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TO

A YOUNG NATURALIST

ON

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BY JAMES L. DRUMMOND, M.D.

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IN THE ROYAL BELFAST ACADEMICAL INSTITUTION;
PRESIDENT OF THE BELFAST NATURAL HISTORY SOCIETY;
HONORARY MEMBER OF THE NATURAL HISTORY SOCIETY OF
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&c. &c.

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LETTERS

TO A

YOUNG NATURALIST.

May, 1830.

MY YOUNG FRIEND,

A WELL-DIRECTED attention to the works of nature tends in an incalculable degree to elevate our conceptions of the omnipotence and unerring wisdom of the Almighty, and is congenial to every innocent and amiable propensity of the human mind. It is to be regretted, however, that comparatively few persons have distinct or enlarged ideas of the world around them. The objects which have been familiar to their eyes from infancy, are considered only as matters of course; and while every thing that appears in the vast page of creation is, one should think, tempting them to a perusal of its origin and history, the general bias, unfortunately, is to put a chief value on deviations from nature, and to consider only as curious and interesting those irregular productions which break through her laws, which mar her beauty, which are aberrations from the wisdom that formed every thing in perfection, without blemish, and without possibility of amend-

ment. Living in the midst of all that is magnificent, or awful, or lovely; in scenes where the hand of God has fixed its seal and impressure in the strongest characters, we yet neglect these familiar and ever present manifestations of his power; while to every thing bearing an appearance of novelty, however monstrous or absurd, we attach an undeserved and childish importance.

This, I am satisfied, arises principally from the general neglect of natural history as an ordinary branch of education. Indeed, so far from children being encouraged to look upon the animals around them as objects formed by the Almighty, and therefore cared for by him as well as they themselves, they are too often taught the unjust and pernicious lesson of destroying, and even, what is worse, of tormenting, all such unfortunate creatures as may fall into their power. To seize butterflies, and tear off their wings; to spin flies, by thrusting a pin through their body; to torture crabs, by dragging off their legs, are but a few of the many cruel practices followed by boys, and without the slightest interference on the part of parent, teacher, or friend, either to prevent the act, or point out its criminality. I assert not that this is always the case; but that it very generally is so cannot be denied. It would be otherwise, I believe, were natural history more cultivated, and especially were it taught and attended to as a part of natural religion. It must, to a certain extent, indeed, excite devotional feelings, however studied; but I know, and feel, that the usual pursuit of it as a science, and its study in that disposition of mind which adds to the deve-

lopments of science a constant reference to the Deity, and an unceasing appeal to final causes, are very different from each other. The one may, to a certain degree, degenerate into a mere love for the curious, or have for its chief end and aim the perfection or improvement of some system of classification, without looking much farther; the other must ever continue to ennoble our minds, to raise us every day to higher and higher conceptions of the power and wisdom of God; and to afford a happiness as pure, perhaps, and as permanently exquisite, as man in his present state of being can possibly enjoy. And still, in these studies, and in all the meditations to which they may give rise, there can never be a fear of running into dangerous extremes of enthusiasm, nor into a blind and arrogant confidence in ourselves, or in the rank we hold in the creation. The more we can understand of the works of God, the more we must be convinced of his power, and necessarily the more humble must we seem in our own eyes; but, at the same time, that cannot be a slavish humility: for, in proportion to the evidences of his omnipotence, we find those of his goodness at least equal; and, consequently, while we feel awed by his majesty, we are at the same time impelled to confide in his justice, and to consider him as the friend, and not the tyrant, of our race.

In our present correspondence, therefore, my object will not be to lead you to the study of natural objects through the medium of any artificial system: and I shall, for some time to come, not wish you to be either a scientific zoologist, botanist, or miner-

alogist, but that you should first learn to look on animals, plants, and the various phenomena of the earth's structure, with a constant allusion to their Maker; so that when you afterwards come to attend to scientific distinctions, and to systems of science, you may have acquired the habit of extending your thoughts beyond these, and looking through them, and the works of which they treat, up to the great Spirit who formed the universe, and all which it contains. Without further preamble, then, let us commence our task. It matters little where we begin; yet it may be as well to take our first lessons from things which are common, and with which we have from childhood been familiar.

At this season of the year there are few objects among the younger classes of the community so anxiously sought after as a bird's nest: and were they taught to consider that beautiful and ingenious piece of work as it deserves, the lesson might be useful to them during life. On the contrary, however, the natural feelings which should be attached to the contemplation of such an object are allowed to run in a wrong channel, and thoughtlessness and cruelty are permitted to take place of the tender and gentle impressions which so ingenious, so beautiful, and so perfect a production, and, above all, the sacred use which it is intended for, ought to inspire.

It is a common practice in this part of the country for boys to play at what is called *blindstab*, that is, to rob a number of birds' nests; to place the eggs in parcels upon the ground, and to go in rotation blindfolded in the direction they are placed in, and,

by beating about with a stick, to break as many as possible.

Now, let us ask, what are the objects destroyed so wantonly in this idle and vicious practice? Why, they are birds' eggs. Yes; and with most people there the matter rests. But I wish you not to be content with so barren a conclusion. An egg is one of the most surprising productions in the world. Suppose an egg were put into the hand of a person who had never known nor heard of such a thing, and the question were put to him, to what good purpose could it be applied. He would, of course, ascertain what were its contents;—and what would he find them to be? A glairy, colourless liquid, surrounding another liquid of an orange or yellow colour. You might let him make thousands of conjectures; but could it ever enter into his mind that such a substance would produce a sparrow, a thrush, a swan, or an eagle? But even give him a hint on the subject—give him an egg, and let him know that it will bring forth a dove. After this advance in a knowledge of the thing, put him in possession of another egg. He may see, of course, that its colour and size are different from the one that produced the dove; but the *contents* are exactly similar,—so far, at least, as human perception can ascertain; and what would then be his conjecture? Could his imagination ever conjure up, even in the brightest moments of inspired genius, the idea of a peacock? Yet the peacock, in all its glory of dazzling colours, is the product of a little glairy fluid contained in a capsule of chalk, and in nowise different, so far as we can perceive, from what pro-

duces a barn-door fowl. Has not the hand of Divinity here written, almost without a metaphor, in letters of gold, the wonders of its creative power? Look at a single feather of the peacock; consider that its shining metallic barbs, its superlatively beautiful *eye*, and all the wonders it exhibits of iridescent, rich, and changeable hues, according to the angle in which it lies to the light; that its form, its solidity, its flexibility, its strength, its lightness, and all its wonders (for in the eye of intelligence every part of it is a wonder), had their origin in a little mucilage; and then consider whether, in looking on such an object, we should be content with thinking no more about it than simply that it is a peacock's feather. Yet this is too much the practice: above us, and below; on the right side, and on the left; in every element, in every situation, the works of Almighty Power are present, and all abounding in instruction of the highest kind; and that they make not the impressions they should do upon us, is chiefly owing to the extraordinary anomaly, that natural history forms no necessary part of the education of young or old.

But if a single feather be so wonderful a production, what are we to think of the entire bird? Those who are unacquainted with the animal economy, have little idea of the mysterious operations which are constantly in action in a being possessed of life. The circulation of the blood; the processes of respiration, digestion, chylification, absorption, nutrition; the contraction of muscles to perform motion; the distribution of nerves for conveying sensation; the organs of the senses, the brain and

all its inscrutable connection with intelligence, instinct, and perception;—these, and many other things in the animal economy, are so wonderful, that, could they be attended to, they must excite astonishment in the coldest bosoms; and yet all these results are the produce of an egg.

Let me give you another illustration of this subject. Who is unacquainted with the leviathan of Job, the crocodile of the Nile? Clothed in a coat of armour of the most elaborate mechanism, and sufficiently strong upon the back to resist a musket bullet, armed with at least sixty formidable teeth in his jaws, and the latter opening to an extent even proverbial, he may truly be considered as the monarch, or rather the powerful tyrant, of those mighty streams which he inhabits. He grows to twenty-five or thirty feet in length, and to the thickness of a horse. He lies in wait near the banks of the rivers, and, in a moment, swallows any man, or dog, or other animal that is unfortunate enough to come within his reach. He devours large quantities of fish, and will even drag the tiger, it is said, under water, and destroy him. In all ages, indeed, the crocodile has been considered as one of the most formidable animals in existence: and we might almost receive literally the following passages in Job:—"The sword of him that layeth at him cannot hold: the spear, the dart, and the habergeon. He esteemeth iron as straw, and brass as rotten wood. The arrow cannot make him flee: sling stones are turned with him into stubble. Darts are counted as stubble: he laugheth at the shaking of a spear." And, from the same, we may ask, "Wilt

thou play with him as with a bird? or wilt thou bind him for thy maidens?" And, after all, what is the first state, what is the origin of this tremendous animal? Why, he is produced from an *egg*, and that egg has a hard calcareous shell like the egg of a bird, and its contents are similar. If broken into a bowl, no eye could perceive a difference; and, in its entire state, any one, not aware of its true nature, would at once pronounce it to be a *bird's egg*. In some parts of Africa, indeed, it is a favourite article of diet. These eggs are deposited in heaps of about forty in one place, in the mud or sand of the shore or banks of the river; and this being done, the cares of the parent are over.* The *bird* has to sit on *her* eggs in order to impart to them the genial heat necessary for their development; but the rays of the sun awaken into action the hidden spirit of life that lies concealed within the egg of the crocodile; and the young leviathan, the moment it bursts from its imprisonment, at once crawls to the water, and commences its life of blood, stratagem, and rapine.

* The crocodile is said to lay in all about 400 eggs, in heaps of about 40 each.

LETTER II.

I SHALL commence my present letter by stating, that I wish to impress it early on your mind, never to consider any of the genuine works of creation as imperfect, or as bungled in their formation, or that they are any thing but what their Maker intended them to be. However, commonly, the term "monster" may be applied to beasts of prey, to fishes of various kinds, to toads, bats, &c., you must recollect that, strictly speaking, there are no monsters in nature. Those individual animals which are born with supernumerary or deficient members, and are called monsters, are unnatural beings, and deviations from the perfection with which the whole scheme of nature has been planned. They are, indeed, in almost all cases, caused by the aberrations from natural modes of living produced by domestication. But the lion is not a monster, nor the tiger, nor the rhinoceros, nor the vulture, nor the eagle, nor the shark; there are no monsters of the deep, and none of the land. All the wild animals on the globe are pursuing the habits and propensities which God intended they should, and however bulky some may be, or however ugly or deformed others may seem in our eyes, they are all perfect in their kind; there is no mistake about them, and there is not one of them which is not a miracle of creative power. Never, therefore, con-

temn an animal because it may seem deformed, or ugly, or uncouth. Try to find out its history, the uses of its different parts, and as much of its whole economy as you can; and depend upon it you will find no marks of imperfection or ugliness there. The fact, indeed, is, that when men pronounce animals ugly, they do so, in almost every instance, from sheer ignorance and unacquaintance with nature; and they are just as eager to destroy an animal for its beauty as for the reverse. When a brutal man sets his foot upon a frog, and crushes it to death, why does he so? Because it is ugly in *his* eyes. And when the same shoots a kingfisher, why does he perform that act? — "Why," he will tell you, "because the bird is so pretty:" though, in the end; he can make no more use of the bird than of the frog. Now, this is no bad specimen of a monster; a man who will thus wantonly and unjustly destroy that life which none but God could have given, and which is as dear to its possessor as his is to him who commits the uncalled-for and cruel act.

I hope you will learn better to appreciate the works of nature, than to destroy any thing without having a sufficient reason for so doing. Kill nothing through mere wantonness or caprice; for such practices can only belong to an unfeeling and unamiable mind. If an object is to be gained worth the sacrifice, then let the animal die; but let its death be as easy as possible: and if, for the sake of science, you must deprive animals of their being, make it a point otherwise to save all you can. In your evening walk avoid the snail that crosses

your path: if a beetle lies sunning itself on the highway, where the next passing foot may trample on it, throw it out of danger over the hedge; if an insect is struggling in the water, save it from drowning; "and," perhaps you would say, "if a fly is uttering its death-cry in the embrace of a spider, save it from the clutches of the robber?" Surely not; the spider is committing no wanton, no unnecessary murder. You might with equal justice cut the net of the fisherman, and commit his capture to the deep. The spider may have had *his* net spread for weeks without success until now, and the fly you would rescue is as much a lawful prize as a trout hooked by the tackle of old Walton himself, — with this difference, indeed, that the old piscator fished for amusement, but the spider entraps *his* prey for a livelihood; so that, in depriving him of his fly, you might subject him to an additional three weeks' fast.

By doing acts of humanity you may more than counterbalance the waste of life requisite for the completion of your cabinet or museum, if you form either; and it must be gratifying to a gentle and feeling disposition, such as I wish you to possess, to be able to say, with the authors of that great work, the *Introduction to Entomology* *, "for my own part, I question whether the drowning individuals which I have saved from destruction would not far outnumber all that I ever sacrificed to science."

* An Introduction to Entomology, or Elements of the Natural History of Insects; with Plates. By the Rev. Wm. Kirby and William Spence, Esq. London, 1822.

Suppose, now, that in imagination you accompany me in a late evening walk, that we may reflect on some of the animated objects which at that time may present themselves. In the end of a summer's day, when the sun has drowned his effulgence in the western wave, and the twilight is spread shadowy over the face of things, nature assumes her softest and apparently her most peaceful aspect. The birds have retired for the night; the beasts of the field have taken to their "grassy couch;" but still there are some species of both which are in full activity, searching for their prey. Such are the bats, the owls, the goat-sucker, the field-mouse, and a number of others; while the numerous family of moths are winging their way through the air, having escaped from their retreats, where all day they had lain unseen, and protected by the spreading verdure of herb and bush. The nightingale too, in those countries favoured with her presence, then "tunes sweetest her love-labour'd song," and "all night long her amorous descant sings."

Let us attend, then, a little to one of these, the *common bat* (*fig.* 1.), an animal which, owing to its

Fig. 1.

unusual formation and singular appearance, has come in for a more than ordinary share of vituperation. "An animal," says Buffon, "like the bat, which is half a quadruped and half a bird, and which, upon the whole, is neither the one nor the other, must be a *monstrous* being; because, by uniting the attributes of two opposite genera, it resembles none of those models presented to us in the great classes of nature. It is an imperfect quadruped, and a still more imperfect bird. A quadruped should have four feet, and a bird should have feathers and wings."

Now the bat, I must observe, is not "half a bird," and I cannot conceive why it is thought to partake of the nature of a bird at all, except that it has the power of flying; but on that principle the butterfly is a bird, and the moths on which the bat feeds are birds; the flying fish is a bird; and, in short, you might as well say, that a goose is a man because it walks, as that a bat is a bird because it flies. Neither is it an imperfect quadruped; for we must not confound animals of the most different kinds and formation simply because they have four feet. Were this to be our guide, we should arrange the lion and the frog, the elephant and the toad, the antelope and the crocodile, in the same class, which would be the height of absurdity. The bat is a mammiferous animal, (that is to say, it suckles its young,) and, in its kind, it is just as perfect as the lion, the elephant, the antelope, or any other mammiferous species whatever.

Its flight has been described by the same author as "rather a desultory fluttering, than flying, which

it executes very awkwardly. With difficulty they raise themselves from the earth, and never fly to any great height: they quicken, relax, or direct their flight in a manner the most bungling and imperfect." This is partly true; the motion of the bat in the air is a fluttering one; and hence the animal had formerly the name of flitter or flutter mouse, and to ordinary apprehension it may seem awkward, but that it is "bungling and imperfect" I cannot admit. The Almighty never executed one of his works in a bungled or imperfect manner, as we shall always find when we ascertain the *real* state of such things as may, to our conceptions, appear wrong. This desultory fluttering of the bat is the very kind of flight which could be most useful to it; as it brings the animal into more frequent collision with its prey than a more regular or bird-like flight would. It feeds chiefly on moths, which it pursues with open mouth, and the moths having a similar kind of flight, it is able to follow them in their windings and doublings with ease and certainty. The opinion that it raises itself from the earth with difficulty was long since disproved by Mr. White*; and if it do not "fly to any great height," there is a very good reason for that: it would find either very few or no insects there, and therefore it has the good sense to keep at a less elevation, where it is sure of its prey. Buffon has much more in the same false strain; but there is no occasion to follow him farther.

The wing of the bat is very commonly spoken of

* Natural History of Selborne, Letter XI.

as a wing of leather, and the idea attached to this term undoubtedly is that it is composed of a callous membrane; that it is an insensible piece of stuff, like the leather of a glove or of a lady's shoe: but nothing can be farther from the truth. If one were to select an organ of the most exquisite delicacy and sensibility it would be the bat's wing: it is any thing but leather, and is, perhaps, the most acute organ of touch that can be found; though it is not easy to understand why it should be so. Spallanzani, a philosopher as noted for his extreme cruelty as for his ingenuity and love of research, had observed that bats could fly with great certainty in rooms, however dark, without striking against the walls. He found that when their eyes were covered they could fly with as much precision as before; and, even when their eyes were put out, no alteration in this respect was observed. When branches of trees or threads were suspended from the ceiling, they avoided them, nor did they even brush the threads as they flew past or between them; and even when the space between was too small to admit their expanded wings, they contracted the latter so as to suit their dimensions to the breadth of the passage. Spallanzani thought that the bat must possess a sixth sense. The organs of vision had been destroyed, and therefore it could not be by sight that they avoided all obstacles. In many individuals the ears were stopped, so that it could not be by hearing. In others the nostrils were stopped, so that it could not be by smelling; and taste is out of the question.

The following remarks from Cuvier are suffi-

ciently demonstrative, I think, that it is by the acuteness of the sensation of touch in the wing, and not by any additional sense, that the phenomenon is to be accounted for: — "The bones of their metacarpus *, and the phalanges of the four fingers which succeed the thumb, are excessively elongated. The membrane which unites them presents an enormous surface to the air; the nerves which are distributed to it are numerous and minutely divided: they form a net-work, very remarkable for its fineness and the number of its anastomoses. It is probable that, in the action of flight, the air, when struck by this wing or very sensible hand, impresses a sensation of heat, cold, mobility, and resistance on that organ, which indicates to the animal the existence or absence of obstacles which would interrupt its progress. In this manner blind men discover by their hands, and even by the skin of their faces, the proximity of a wall, door of a house, or side of a street, even without the assistance of touch, and merely by the sensation which the difference in the resistance of the air occasions." Why the wing of the bat should have so exquisite a sense, it is not easy to account; that it has a use, and that an important one, we cannot doubt: for it would be folly to suppose that it is there by chance. Can it be for enabling the animal to avoid the trunks and branches of trees and other objects during its twilight excursions? This would seem a very probable con-

* Lectures on Comparative Anatomy, translated from the French of G. Cuvier, by Wm. Ross, vol. ii. p. 594. Lond. 1802.

jecture; but then there are birds, the goatsucker, for example, which pursue their prey at the same time, and with the velocity of a swallow, which seem to require no such provision, though one should think they would be in much more danger of dashing themselves against objects in the way. Can the sensibility of wing serve to intimate the contiguity of a moth or other insect, and thus enable the bat to turn very suddenly in a direction towards it; or does it answer as a thermometer, by which the bat can regulate its time for going abroad or remaining at home? These conjectural questions may be all wide of the mark; but as they *are* conjectural, you will only receive them as such.

The bat, like many other animals, is ordained to live on insects; and were the numbers of the latter not kept in check, such are their powers of increase, that they would destroy the vegetable world. The swallows alone during the day devour millions of them; and in the twilight and the dawn the bats and goatsuckers keep in check those which come from their hiding-places at those times. The bat may sometimes be seen in cloudy weather in the daytime hunting about for flies, and even in clear weather and sunshine it follows the same employment over the surface of pools shaded by lofty trees, and where the sunbeams cannot enter.

As the season advances, however, the supply of insects diminishes, and at length is nearly cut off. In this case the swallow tribes migrate to southern countries, and such is their rapidity of flight, that in a few days, or even perhaps in one, they can transport themselves to latitudes of sunshine and

plenty. But however well adapted the sensitive wing of the bat may be for conveying its possessor through the glades of a forest, or over the surface of a pool, it is totally inadequate for long journeys. The bat could not migrate to other latitudes, yet it survives the winter, and is safe, when the waters are locked in ice, and the wide earth covered with a mantle of snow. In severe seasons, when many birds perish, the bat lives. It survives all the rigour of the elements, and when the genial month of May arrives, it again sallies forth, to enjoy its old haunts, the glade, the pond, and the river. It is not even conscious of the presence of winter; it lies torpid and insensible, and however the storm may rage, it reposes in its little nook, some hole in a ruined building, or in the eave of a house, or in some old wall, or hollow tree, in a profound and deathlike sleep, undisturbed by the roar of the elements without, or by unpleasant dreams within. Many animals besides the bat lie dormant through the winter, a fact known to every one, but, like too many other facts, from being well known is proportionally little thought of.

And yet this hybernation, as it is termed, is a very wonderful example of divine care; and that an animal, for the purpose of enabling it to exist through the winter, should be so different in its constitution from others as to survive under circumstances, the least of which would, in a few minutes, put a period to their life, is sufficiently strange. The common mouse, or any quadruped not intended to hybernate, would in a very little time die, either if the respiration became so suspended,

or the action of the heart so weak, or the temperature of the body so low as happens in the bat; yet there is nothing in the anatomical structure to account for the difference, or throw any light whatever on the subject, so far at least as our present knowledge extends. And here let me remark to you, that it is right and proper for us to use every endeavour to understand the causes of the phenomena of nature; but let us at the same time remember, that there are always limits at which we must stop. We are called upon, by all the works which God has made, to study him in them, to find out his laws, to go as far in obtaining a knowledge of him and his creation as our powers of mind and observation can carry us; but whenever satisfactory proof fails us in any point, we should pause, instead of forming fanciful theories, and either promulgating or embracing them as truth. Further investigation may bring new light to the subject, and we may depend upon it that every new light will prove to be a new manifestation of creative power and wisdom. The cause of hybernation is, I fear, a secret which we shall never be able to solve, which we are called on to admire, but which we can never explain; and this is not the less likely to be the case that various theories have been formed on the subject, for these have hitherto been all to no purpose, whatever praise of ingenuity we may be inclined to attach to their authors.

The female bat, though she brings forth two young ones, forms no nest, nor does she require one. It is said that on going abroad in search of food she sticks them to the wall by their claw,

that is to say, the thumb nail, and that they remain there immoveably fixed till her return. It is perhaps more probable that they remain attached to her breasts, for it is known that she can fly with perfect ease carrying one at each, and both forming a weight nearly equal to her own; a proof, if any were requisite, that her wavering flight is not from weakness. The instinct which in this case makes the young cling to her is also worthy of remark, and is analogous, in some degree, to that which makes the young monkeys adhere to the mother. Thus, in the woods of Surinam, flocks of monkeys are often seen scampering with great activity, and making amazing leaps from tree to tree, the young keeping a sure grasp on the mother's back, and at a distance resembling little knapsacks.* There are many other particulars respecting the common and other bats, to which it is not my object at present to advert; therefore farewell.

* See Stedman's Surinam.

LETTER III.

There are few circumstances in which nature seems more interesting than when, in some soft mild day of Spring, we trace up to its source a romantic mountain stream. Commencing at the sea-shore, where it flows into the mighty world of waters, and is lost, we follow the banks of the rivulet in its course through the valley, where in some places it gurgles with silver sound over the pebbles, and in others settles in broad placid pools, which, like polished mirrors, reflect back the trees and plants that fringe their margin. The birds are busy in constructing their nests, and in pouring out the melody of their song; while in the intervals, the busy hum of the insect world falls not less pleasingly upon the ear.

The plants which here, at this time, exhibit their blossoms, are chiefly the primrose, the lesser celandine, the wood anemone, and the wood sorrel. The ferns, too, are shooting up their fronds, now having a resemblance each to a beautifully turned volute. The wild violet, the golden saxifrage, and many others, are also now, at their appointed time, enamelling the turf and mossy banks with their attractive forms and colours. In such a scene there is much to gratify the eye and the ear, and to call up our thinking powers, the exercise of which constitutes our most genuine happiness. We can-

not help being struck by the regularity with which the different species of plants appear in flower at the periods which they have been destined to observe, and we must also acknowledge that this causes a much greater variety in the aspects of nature at different seasons of the year. The flowers of the spring, those of the summer, and those of the autumn, come regularly at the time when experience has taught us to expect them; but we never see the order reversed, we never see the autumn flowers come first and the spring flowers last. Nature, when left to herself, is always true to her own laws, and here, as in every thing else, we have evidence of design and of perfect government.

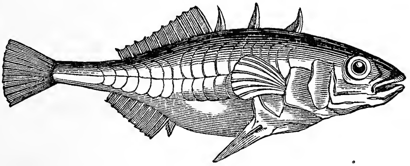
When we next attentively inspect any of these flowers, can we help being astonished at the exquisite structure which they exhibit? Can any thing surpass in beauty the delicate frail corolla of the wood-sorrel, with its purple veins spreading their reticulations through its semi-transparent petals? and yet it is by no means so interesting an object as the more vulgar coltsfoot, or the daisy, the numerous little bells which constitute their centre or disc, appearing, when magnified, most exquisitely beautiful.

These things, however, must be examined to be understood; for, like innumerable other objects in nature, though they speak distinctly and impressively to the feelings, yet the language they use cannot be communicated by any but themselves. This leads me to recommend to you the practice of examining *minutely* the different plants and animals

you meet with. Let your magnifying-glass be no day idle, for it is in the miniature world that most variety, most beauty, most elaborate mechanism, most wonderful displays of creative wisdom are to to be found.

The animated world affords better grounds for displaying in language the wonders wrought by the Almighty hand. Partaking of the mysterious principle of animal life ourselves, we can better comprehend the actions of living beings, and we are naturally more interested in their economy and structure, than in those of vegetables. Let us, therefore, turn our attention to some of the animals which may occur in our solitary ramble. We shall first look into the deeper pools of the rivulet, where the current is too weak to produce a ripple, and there we shall observe shoals of little fishes, from an inch to two inches each in length. These are the common Stickleback (*fig.* 2.), a species very

Fig. 2.



frequent in almost all our lakes and rivers, as well as in the sea, especially in the sheltered inlets of estuaries. It belongs to the genus GASTEROSTEUS of Linnæus, of which there are three British species; the three-spined, the ten-spined, and the fifteen-spined Sticklebacks. Our present

species is the three-spined (Gasterosteus *aculeatus*). It is called also the Banstickle, and the Sharpling. Spricklebag, evidently a corruption of stickle or prickle back, is the common name it bears in the north of Ireland, while in the south it is called a *pinkeen*.

It is a very beautiful little creature, though, being so common as it is, this assertion would, I fear, by most people be laughed at. Should there be any doubt respecting the species, you will recognise it at once by the three spines, or sharp long prickles, which are on its back, and by the ventral fin being "a plate-like spine of three parts."

Small though the species is, it sometimes is applied to an economical use by man, since, occasionally, it appears in such vast shoals as even to be used for manure, and also for fattening ducks and pigs. Pennant states, that in the river Welland, every seven or eight years, the sticklebacks which have been washed out of the fens of Lincolnshire are in such multitudes as to be used for manuring the land; that trials have been made to get oil from them; and that so innumerable are their myriads, that a man, for a considerable time, could make four shillings a day, by selling them at a halfpenny per bushel. They are said to be taken in great quantities about Dantzig, for the purpose of extracting an oil from them. Mr. Daniel, in the second volume of his Rural Sports, states, that in the river Cam he had seen them taken by myriads, with large landing nets fixed on short handles, for the purpose of manuring the land.

This little creature is said to be very pugnacious,

and to attack fishes much larger than itself. The spines of the back can be raised or depressed at pleasure; but I should suppose that the spines of the ventral fin would best answer the purpose of offensive weapons. And here, I must observe, we have a very remarkable and beautiful piece of mechanism. The articulation of these fins is of a very rare kind. If a specimen that has been dead for some time, and is somewhat dried up by exposure to the air, be examined, you will observe that there is a very remarkable girdle of bony plates surrounding the body, and connected with the spines. This girdle, indeed, seems to be subservient altogether to them, and is intended to give them a firm foundation. The central portion of the ventral or belly fins, seems to be a soldering, as it were, of the two together into one solid triangular plate, and into this the ventral spines can be fixed by their base at pleasure. The root of the spine has a hook, and there is a hole in the immoveable plate for receiving it. To implant it *there* is at the option of the fish, and the process of so doing might not inaptly be compared to that of a soldier fixing his bayonet. When the stickleback wishes to place this spine or weapon in a position for combat, it extends it, and fixes the hook in its rest, where it remains perfectly rigid and immoveable as long as the animal pleases; but when it desires the contrary, it turns the hook out of the cavity, and then the spine falls flat to the belly.*

It is said that the ova of this diminutive fish are

* See Cuvier's Comparative Anatomy, translated by W. Ross, vol. i. p. 132.

larger than those of a cod; and, indeed, I may observe, that the bulk of an ovum, or egg, often bears no kind of proportion to the size of the animal it produces; and the same observation will apply to the seeds of plants: a bean, for example, is as large as an acorn, which produces an oak; and a pea is as big as a cherry-stone, and much larger than the pippin, which gives origin to an apple-tree.

The stickleback is very voracious, and will readily seize a bait on a small hook, and thus it is sometimes taken by anglers for the purpose of making it a bait, in its turn, for larger fishes, as the pike and trout.

From the great voracity of the stickleback, it is an injurious inmate of fish-ponds, as it devours the ova or spawn of other fishes; but whether it really inflicts wounds on the larger species with its spines, I know not. It is a very short-lived creature, and seldom survives the third year, at least such is the general assertion of ichthyologists, though I am not aware on what certain authority the opinion rests; whether true or not, this species has been called the *ephemera* of fishes. Its neighbour, the lesser or ten-spined stickleback (Gasterosteus *pungitius*), is considered as the *smallest* of fishes; it is seldom found so long as an inch and a half.

The common stickleback deposits many ova on aquatic plants, and at the bottom, in the early part of summer; and the female, if Donovan be correct, when in roe, assumes a beautiful red colour on the lower part of the head and the belly. It is said to be pestered with worms; and I have often observed it covered with large tumours of a pearly colour and

lustre, caused by collections of a white matter under the skin.

Along with the stickleback, you have another acquaintance here in the deep parts of the stream — I mean your old friend the *trout* — and I presume there are few objects in nature more closely connected with your early recollections, for I know that the first attempts at angling, and the delight felt on hooking a fish and tossing it to the green bank, though it may have been after hours of patient waiting, are never to be forgotten, and can never be remembered without emotions of pleasure. Though I would be an enemy to cruelty of any kind, and though I could now have no pleasure in capturing these inhabitants of the lucid wave, yet I am much inclined to think that the practice of occasionally angling, when I was a boy, in a rocky romantic river passing through a fine narrow valley of some miles in length, tended very much to foster in me a love for nature and natural history, which has always formed a very sweet ingredient in the mixed cup of life, and which, I am very certain, will give still increasing pleasure and happiness in its pursuit till life shall cease.

And certainly there can be few places more favourable to the formation of agreeable impressions from external objects than the scenery of a romantic stream. The ever toiling but never tired element, on its way to the ocean, in which it is to be swallowed up, whether it foam, and rage, and dash into spray as it rolls down a precipitous rock, or ripples around the stones in the river's bed, or glides imperceptibly under hanging banks, where antique

roots shoot out, and bunches of fern show their feathery foliage reflected from beneath, is in all circumstances interesting and delightful. It is under no aspect, however, so pleasing to the boy, and too often, I regret to say, to the man also, as when, on a dark grey day, the trout is rising at the fly. With all my early recollections about me, still I cannot consider angling as an innocent amusement; or if it can with any truth be deemed so, it is (in my opinion at least) when practised with artificial flies, or with salmon-roe, or some other bait not possessing life. To use a living frog, or a minnow or other fish, as is often done, with the hook thrust through its skin, cannot, surely, be called an innocent employment. Though worms seem to have a very delicate sense of touch, and though they seem to suffer much when impaled on the hook, I am not certain that the pain they endure can be compared in intensity with that felt by animals of a higher class under the infliction of similar injuries. Still, however, though we may admit that the worm transfixed by a hook may not experience excessive pain, yet it must still undergo no inconsiderable degree of suffering; and that ought to be sufficient to deter a man of sensibility and humane feelings from pursuing an amusement, if so it must be called, which is to be accomplished by the torture of a weak and helpless creature. There is something, too, appalling in the idea of an animal being impaled on a steel hook, and seeing it writhe in pain, and that only for our sport. In the case of a fisherman by profession, who has to depend on his own skill and exertion for his daily bread, the

thing is different; he must obtain the fish by any means which his ingenuity can invent: but I must regret that so many who are under no such necessity, and especially that men of education and cultivated minds, should condescend to follow this petty employment as a recreation. There is a source of enjoyment in the very scenes where they are thus engaged for hours in capturing, or trying to capture, a few trouts, of a description transcendently pleasing and instructive beyond what could possibly be derived from any such occupation. And what, you will ask, is that? — I answer, the study of nature.

Suppose that you were in a great gallery of exquisite paintings, but that you knew nothing whatever either of the landscapes, the figures, or the architecture represented in them, or of the artists by whom they were executed; do you pretend to say, that you could have as much pleasure in looking at the pictures, as if you knew their whole history, or even a part of it? "No," you will reply; "but still I could admire their beauty, and the skill of the painter." Yes, my young friend; but even here you may, in some degree, be deceiving yourself. You may admire a fine painting as you would a fine and real prospect in nature; but let me tell you, that both in nature and in paintings, people see things very differently from each other. Suppose an artist were to join you in the picture gallery, would he and you see in all points alike, think you? No; he would observe a thousand beauties, a thousand things to give him delight, and inspire him with enthusiasm, of which *you* could have no con-

ception: and the same would happen also, were you placed in natural scenery together. You, indeed, would see the landscape, and you might think it beautiful; but while *you* were only seeing, *he* would be analysing. The effects of light and shade, the groupings of trees, the contrasts and blendings of tints, the aërial perspective, the composition of parts or of the whole, with various other particulars, would find important employment for his thoughts, and give him a vast advantage over the comparatively cold and passive impressions which these characteristic properties of landscape would make on *your* mind. Now, I may observe, that this is a species of study which I would wish you to attend to. You may neither have time nor talent to become a practical artist, but still you may become a good judge of painting, and consequently see Nature herself with a painter's eye; and that, let me tell you, is to see her almost through the medium of a new sense.

I would recommend particularly the practice of sketching from nature. A sketch taken on the spot serves to perpetuate, as it were, the circumstances in which we were at the time placed, and recalls, even many years afterwards, a vivid recollection of scenes which otherwise, perhaps, might have faded from the memory.

To return to our gallery: you see before you a portrait, but you know not for whom it is meant. Should you not, therefore, enquire whose it is? Surely: well, you learn that it is Sir Isaac Newton's. Does this produce any revolution in your thoughts and feelings? do you merely see a picture

now, and nothing further? do not the very tints reflected from the canvass speak of that mighty genius who decomposed the solar ray, and demonstrated, in all the majesty of truth, the compound nature of light? Does not the mere name of Newton, at once connect your thoughts with the great law of gravitation, that binds the planets in their course, and regulates the motions of countless worlds? and for the discovery of this law, do you not venerate the name when sounded in your ear? and would you not feel impressed with a generous awe even on seeing the portrait of that great philosopher? Yes; you could not help it. And why? Because you are acquainted with his discoveries and character. But if you knew nothing of these—had you never heard of Newton—would your being told whom the picture meant to represent, excite any mental emotion? No; because it could make no chord of feeling vibrate, and the picture would not be one whit more high in your estimation than at first. The word Newton could throw no hallowed charm over it, if you knew nothing about him; and you would consider it merely as a painted canvass. No portrait of Newton does, I believe, exist: but this makes little difference,—that of any other great man will support my illustration, and it needs not be amplified.

Now, this is exactly what occurs so often in the great temple (gallery I cannot call it) of nature. A man will go armed with his fishing tackle, and will spend whole hours, day after day, at a river's side, fishing for trout. He sees the animals, the plants, the rocks, the various features of the scenery, the

sky above, and the flood below: he may be pleased, be charmed with them, if he choose to think so; and yet, in the midst of much light, he may be in comparative darkness. What are the animals, the plants, the landscapes to him, if he know nothing more than simply that they are such? There is a secret charm, I grant you, in all these, and an undefinable sensation of pleasurable feelings in our minds respecting them, which I believe to be instinctive, is excited by their view; but still they are like the pictures in the gallery, — they please the eye, we like them, and there, generally, the matter ends. But let me recommend to you to enquire, to put questions, to find out sources of information respecting them. Along with the portrait, get a knowledge of their character and history. Make use of some system of classification, and learn to refer any animal, plant, or mineral you meet with, to its class, order, genus, and species. You will find good instructions on this head in the first volume of Withering's Arrangement of British Plants, so far as relates to botany; but analogous methods are used in the other kingdoms of nature. When the scientific name has been gained, you have a key to the whole history of the species, so far as is known. The synonymes, or references in the system you make use of, will refer you to the authors who have written upon or figured the species you are investigating; and thus you may become intimate with the animals, plants, and minerals you meet with, if you choose to take the trouble, or rather I would say the pleasure, of doing so.

I mean not to insinuate, however, that a systematic knowledge of things is absolutely necessary to enable us to enjoy the productions of nature in a very high degree. On the contrary, I hesitate not to assert that any man, though he be but slightly or not at all versed in science or scientific names and distinctions, may, if he choose, never be at a loss for subjects of exalted and delightful reflection. Let him but look around him, and think of the objects he beholds, and in his thoughts never lose sight of the great and inspiring truth that they are the works of the Deity. If a man in this tone of mind explore the banks of a lake or river, has he not in himself a store of solid occupation much superior to that of throwing an artificial fly or torturing a worm upon a hook? If he sketch the scenery before him, or examine an insect, or dissect a flower, not as things that have come there he knows not why nor wherefore, but as examples of the exquisite workmanship of God, — as objects which were worthy of the attention of *him*, else he would not have made them, and therefore must be worthy of the admiration of us, who have the inestimable privilege of seeing him in his works; that man, I insist, has in himself sources of pleasure infinitely superior to any thing arising from ordinary amusements, or what are commonly called rural sports. In the latter, too, I must observe that the objects are very limited; while the stores of amusement and of true information to be found in the pursuit of natural history are inexhaustible, never ending, and at the same time ever new.

LETTER IV.

Before proceeding farther on our excursion, let me detain you a little by observing, that persons used to angling are well acquainted with one sort of bait which the trout is particularly fond of, and which I suppose you have yourself often remarked, — I mean the *caddis*, or *cadew worm*, called also the straw-worm, or cad-bait, or case-worm. It is common in streamlets and ditches of clear water; but, before calling your attention more particularly to it, I may remind you of the metamorphosis of insects by saying a few words on the common butterfly (Papilio *brassicæ*). This species deposits her eggs towards the end of May, and invariably on the cabbage. Now, this is worthy your attention; — were the eggs laid on a lettuce, or a rose-bush, or a celery-plant, or a leek, or any of the other vegetables in the garden, they would not succeed; because it has been ordered that the young which escape from them can only live on the cabbage. The parent butterfly, as if aware of this, never makes a mistake by depositing the eggs on any other species of plant: but still there is something more required than this. Suppose she placed them on the upper or exposed surface of the leaf, what would be the consequence? They might be shrivelled up by the heat of the sun, or injured by the rain; but what is much more certain, the young, when hatched,

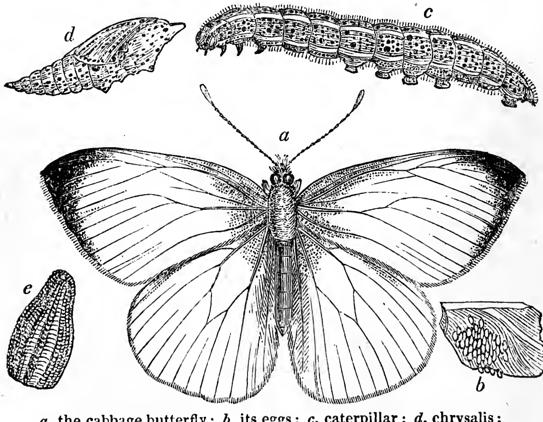
would be exposed to the view of the small birds which prey greedily upon them, and hence they would mostly fall victims, and that at a period when, from their small size, their acquisition could be comparatively of trifling service to the bird. The parent butterfly always attaches them to the *under*, never to the upper, surface of the leaf. It is also said, that if she find the cabbage pre-occupied by the progeny of another butterfly, she will reject it, and seek out one as yet untouched; else the two broods might not have sufficient protection and food.

Nor is the *mode* of attachment of the egg to the leaf a random operation, but the very reverse. The young, when hatched, are to come out of one end, and the eggs, as is the case with those of many other insects, are placed vertically on one end, and disposed side by side, " so as," Mr. Kirby observes, " comparing small things with great, to resemble a close column of soldiers." In a few days the young creep out of the free end of the egg, the other remaining still attached to the leaf.

When, in a former letter, I spoke of the peacock and the crocodile, had I stated that the egg, when hatched, produced a young crocodile in the first instance, but that this afterwards changed into a peacock, you would justly have considered that statement as resting on no better authority than a fable from Ovid's Metamorphoses. Yet, in many instances, we find in insects metamorphoses as extraordinary in appearance as that would have been: this, however, will not apply to our butterfly so strikingly as it would to various other insects, as the dragon-flies, water-beetles, and many more;

and yet even here there is sufficient cause for admiration. When the egg is hatched, does a little butterfly proceed from it? No; but a creature very different in appearance, a crawling worm, or, in other words, a caterpillar. The young caterpillar feeds on the leaf of the cabbage, and in a short time grows to some hundred times its original bulk. About the end of June it has acquired its full growth; and then, influenced by that invisible Guide whose operations are so conspicuously evident in the insect kingdom, it leaves the plant, which can now be of no farther service to it, and, seeking the shelter of some tree or wall, it climbs to a certain height, fixes itself in a perpendicular direction, casts its skin, which it had done several times before, and in a few hours is changed into the chrysalis (*fig.* 3. *d*), being altered almost as much

Fig. 3.



a, the cabbage butterfly; *b*, its eggs; *c*, caterpillar; *d*, chrysalis; *e*, egg magnified.

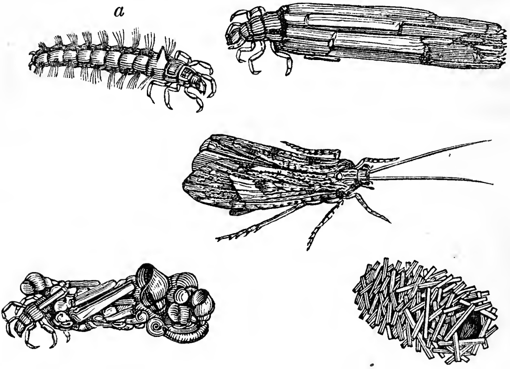
in appearance from the caterpillar as either is from the butterfly. This chrysalis is attached by several silken cords which pass across the thorax, and by this means it is secured from the chance of falling during the period of its sleep. In this state it remains about sixteen days, and then bursts from its case, the complete butterfly. Should the egg be hatched late in summer, so that the chrysalis is not completed till towards the end of September, then it remains all the winter, and the butterfly appears in the ensuing spring.

Insects, from the time they leave the egg till they assume the chrysalid state, are named *larvæ;* but many of these have forms very different from that of the caterpillar, or larva of the butterfly; and such is the caddis worm. This is the larva of what is commonly called the May-fly, often the water-fly; but many species, and some even belonging to different genera, go under these denominations. Without, however, attending to species, it is sufficient at present for us to consider the caddis, or cadew worm, simply in relation to its general history. The generic name of the perfect insect is Phryganea; and the larvæ are well known from their practice of forming cases of extraneous bodies, in which they enclose and protect themselves. You have often, in streamlets and pools, observed bits of straw as it were, or fragments of wood moving at the bottom: these are the cases I allude to.

The larva of the phryganea is a long jointed worm, furnished on the fore part of the body with six feet, which, as well as the anterior part of the animal, are enveloped by a firm crust, like the skin

or covering of a beetle, though not so strong: but the hinder parts of the body are quite soft and unprotected (*fig.* 4. *a*). I may remark, that we

Fig. 4.



Larva, cases, and perfect insect of the genus Phryganea.

have examples of other animals being partly enveloped in a strong crust, or coat of mail, while the rest of the body is covered merely by a soft skin; such are the Hermit-crabs — one species of which, Cancer Bernhardus, or Bernard the Hermit, is common on many of our shores, and is vulgularly considered as a young lobster. To protect the naked part of his body, he takes possession of some empty shell, and retreats into it, tail foremost, and there is secure from the attacks of enemies which otherwise might annoy or destroy him. As the crab grows in size, his house, of course, becomes too small, and he has then to search for a larger; which being found, he leaves the old, and takes

possession of the new dwelling, till he is again obliged to make another flitting to gain further accommodation.

The larva of the phryganea has a different mode of proceeding. One might suppose it next to an impossibility that an animal resident in water could spin a thread, and that a strong one, or that it could form for itself an envelope not unlike a mantle of silk; yet such is the case: and there are animals living in water which can spin threads more durable and strong perhaps than is done by any on land, the silkworm not excepted. You know the common muscle; it spins threads of remarkable strength,— and why?—that it may moor itself to the rocks and other substances, and thereby save itself from being cast ashore by the violence of the waves; and of these cables the animal can spin many hundreds, though it proportions their number to the risk of shipwreck to which it may be exposed. When subjected to the violence of a turbulent sea, it increases the number, and when in secure and sheltered spots it makes them less numerous; yet how many people have been acquainted with the muscle all their lives, and with its *beard* (for that is the name given to its mooring apparatus), without ever for a moment thinking on the subject!

As illustrative of this property of the muscle, I may mention, that its aid has been called in to assist in securing by its cables even works of human construction. At the town of Biddeford, in Devonshire, there is a long bridge of twenty-four arches across the Towridge river, near its junction with the Taw. At this bridge the tide flows so rapidly

that it cannot be kept in repair by mortar. "The corporation, therefore, keep boats in employ to bring *muscles* to it, and the interstices of the bridge are filled by hand with these muscles. It is supported from being driven away by the tide entirely by the strong threads these muscles fix to the stone-work; and by an act, or grant, it is a crime, liable to transportation, for any person to remove these muscles, unless in the presence and by the consent of the corporative trustees." *

To return to our larva of the phryganea; it also is a spinner, but for a somewhat different purpose. The muscle moors itself to the rock, but the larva carries the bodies to which it is attached along with it. This naked and unprotected creature forms a case, or habitation, in which it lies as in a citadel, secure from the generality of its enemies. The inner wall of the case is composed of a substance like silk; but it must be evident that this of itself would be but a weak defence, and the larva is not of a similar way of thinking with the currier in the besieged town, who insisted that there was nothing for the defence of a city like leather. It attaches to the silken wall an outer battery, either of stone-work composed of bits of gravel, or of pieces of wood, or grass, or dead straws, or rushes, or small shells, &c.; and thus there are nearly as many varieties of the case as there are species of the insect.

In the generality of the structures formed by insects, either in the larva or perfect state, the greatest exactness and regularity are conspicuous;

* Daniel's Rural Sports.

but in the present instance this is not so; and yet the circumstance is any thing but an imperfection. On the contrary, indeed, it evinces, like every thing else, an inscrutable and all-powerful wisdom. The caddis-worm is specifically heavier than water, and therefore, in constructing its case, it is of the utmost importance that it be made neither too light nor too heavy: if the former, it would float; and if the latter, it would prove troublesome and inconvenient for the animal to drag along. It has the skill, therefore, to form the case of the exact degree of buoyancy necessary: should it be too heavy, it attaches to it a piece of straw, or wood, or other light substance, to give the necessary levity; and if too light, it gives the due quantum of ballast by glueing on a stone or shell. Now, this being the fact, we may see at once that the building of the caddis worm must of necessity be irregular; but it is also obvious that the very irregularity is connected with an admirable instinct. The animal knows nothing of physics, it knows nothing of gravitation, it has no conception why a straw should float, or a stone sink; and in this, as in innumerable other instances, while we see the ingenuity of the act, and the unerring certainty with which the end wished for is accomplished, we are brought to the inevitable and delightful conclusion, that this is the work of God.

The great object in forming the case is to procure a defence and covering, and the lightness or weight of this we may observe to vary according to situation: thus the caddis worms which inhabit streams generally form their house of gravel, else

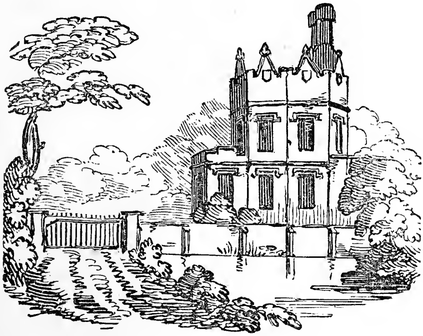
it would be carried down by the current; while those found in ditches, ponds, and other still waters, are of lighter substances, and very near the specific gravity of the water. You may find many more particulars respecting these larvæ than it is necessary for me to advert to here; for my object is not to exhaust the subjects on which I write, but rather to stimulate you to enquire for yourself. One more circumstance then, and we shall go to something else.

We are to recollect that the case-worm is now in its first state after being hatched from the egg; but it has, before assuming the fly form, to pass through the intermediate one of the pupa; and how is it to be protected from its enemies, while lying in that torpid, unconscious condition? Hear what Mr. Kirby says:—"Since they must reside in these cases when they are become pupæ, till the time of their final change approaches; if they are left open, how are the animals, now become torpid, to keep out their enemies? or, if they are wholly closed, how is the water, which is necessary to their respiration and life, to be introduced? These sagacious creatures know how to compass both these ends at once. They fix a grate, or portcullis, to each extremity of their fortress, which at the same time keeps out intruders and admits the water. These grates they weave with silk into strong threads, which cross each other, and are not soluble in water."*

You cannot help seeing from this history, and

* Introduction to Entomology, vol. ii. p. 264:

it is but one among millions, what instruction is every where to be found, were we but to search for it. The account I have laid before you, even as a matter of curiosity merely, is highly interesting; but, however powerfully we may be influenced by a love for the curious, let us not lose sight of that higher motive to investigation, the discovery of the Almighty in all, even the apparently meanest of his works.



LETTER V.

Suppose that in the course of our ramble we should observe, under the impending edge of some mossy bank, or on some old and ivied trunk overhanging the stream, the ingeniously formed nest of the common wren. For so small a bird this nest is of very large size, and is of the form of a hollow ball, with an entrance in its side. I hope you already anticipate the questions I am about to put, and that you are making rapid progress in observing nature in the way I wish. When you meet with a natural object in any respect remarkable, or differing from the usual mode in which analogous objects appear, ask yourself why it is so, and find out the reason if you can. Why is the wren's nest of large size and globular form? Why is it not made like that of the hedge-sparrow, or the robin? And does it not seem like a kind of injustice, that so small a bird as this should have to undergo the labour of forming so large a house, when so many other birds, greatly its superior in size and strength, have no such duty to perform?

In answer to these questions, I would have you to ascertain, in the first place, whether there is any thing that should strictly be called *labour* in the process. Is it an uneasy, a troublesome, an unwelcome business to the bird? Is the latter

under the tyranny of an unjust task-master, who will oblige her to go through a laborious, painful, and irksome work, whether she will or not? You may rest satisfied that such is not the case. Does a mother think it a trouble to nurse the child of her affections? When you yourself have spent whole hours in cold and tempest to erect a man of snow, did you think it a labour? You know, on the contrary, that it was the pleasure, and that alone, attendant upon the work, that could have induced you to do it. The bird also has a pleasure in her work; with this difference, indeed, — your man of snow melted and disappeared under the first sunshine or mild weather, and without any good result having been produced by the labour; but the operations of nature are never without a final object, and that of the wren's workmanship is one of the most important, namely, the continuation of the species. That birds, in fabricating their nests, in hatching their eggs, and in bringing up their young, experience the highest pleasure and gratification, is, indeed, so obvious, that little argument would be necessary to prove the truth of the remark.

You are aware that the whole of this important process is the result of instinct, and that the bird, however great may be the pleasure attendant on it, cannot know that heat is necessary to evolve her family from the eggs, nor even that she is to have a family at all; and indeed, notwithstanding our knowledge of chemistry, we are ourselves, in some points of the process, nearly as much in the dark. We know (which the bird does not) that heat is necessary to incubation; but *why* it should be so,

why an egg should not hatch at a low as well as a high temperature, no man can tell: like innumerable other things, we know the effect resulting from the cause, but why it should do so we can tell no more than a child.

Without a knowledge, however, springing from some source, both of the cause and the effect, the bird might lay her eggs in vain; and besides, that knowledge must be of the most profound cast, that it may meet the varieties and difficulties of different cases. Suppose the ostrich, in the burning soil of Africa, fabricated a nest like a wren's for her family, would the act be a wise one? Certainly not; for, in the first place, it would be an act not necessary; and, in the next, it would probably be fatal to her young — they would risk being smothered in the place made for them. You are not, therefore, to accept in the literal sense the allusions in the 39th chapter of Job, to the ostrich, "which leaveth her eggs in the earth, and warmeth them in the dust, and forgetteth that the foot may crush them, or that the wild beast may break them. She is hardened against her young ones, as though they were not hers; her labour is in vain, without fear; because God hath deprived her of wisdom, neither hath he imparted to her understanding."

Now, many animals take no care whatever of their young, but in no instance does this proceed from ignorance; for, in every example where it happens, we shall find that the young do not want any care of the parent, and, indeed, that the latter could not be of any service to them. Up to the point, however, where knowledge is requisite for

the continuance of the species, we find an admirable instinct guiding the parent, and precisely to that necessary point, but no farther. We have already adverted to the instinct which directs the butterfly to lay her eggs on the *under* side of a cabbage-leaf; and what could she possibly do more for them? it is all that is required or useful, and she performs the task most dutifully. The ostrich does the same, she does all that is necessary; she builds no nest, for that is not requisite; a shallow cavity scratched on the ground is all that is wanted, and that she makes.

Though this bird cannot fly, it can run with extraordinary swiftness, and is in all respects perfectly adapted to the vast deserts which it inhabits. This swiftness of foot enables it to extend its search very far in quest of food, and had it the instinct of sitting on its eggs day and night, it would perish of hunger; for the wildernesses, which are its natural abode, are in general thinly clothed with the vegetables which form its food. But though it roams abroad, and may be absent from its eggs for hours, still it has not forgotten them. The crocodile, when she has covered her eggs in the sand, thinks no more of them, for it is not necessary that she should; but the young ostrich requires a parent's care till it can provide for itself; and, according to the testimony of many travellers, the ostrich in reality, so far from being a careless, is a most attentive mother.

When away on her long excursions for food, the eggs are in no danger from her absence, as they are exposed to the rays of a burning sun; but such is

not the case in the night. Several ostriches join together in the formation of the hollow which serves as a nest, and sometimes even so many as five are united in this kind of partnership, and they regularly sit on the eggs from night till morning. Each lays ten or twelve, so that sometimes in one nest there are fifty or sixty, and in a trench around the nest there are always a number more, which are supposed to serve as food for the young birds that are hatched from those within the nest. If the latter observation be correct, it affords a fine illustration of that attentive care which is bestowed by the Deity on every part of the creation. What more simple or effectual contrivance could be thought of for supplying the young birds with food in the parched and barren deserts where they first see the light? If this be the use of the supernumerary eggs, it is probable that they are of a nature constitutionally different from the others, else one should think that they would undergo a certain degree of incubation, or else spoil from the heat of the sun; for about six weeks are occupied in the hatching of the others. I wish not, however, to deal in conjectures or surmises; the notion may be right or wrong, but the following observation of a distinguished traveller and naturalist inclines me to believe it the former. Mr. Burchell, in the second volume of his Travels into the Interior of Southern Africa, at page 20., thus describes an ostrich's nest, which he met with in a sandy desert: —

"Having halted a few minutes to quench our thirst and allow the oxen to drink, we rode forward by the guidance of the compass in a southerly direc-

tion, over a *sandy plain of fourteen miles*, in which the river twice crossed our course. In some places I saw swallows circling in the air; a cheering sight to the thirsty traveller, and a sure indication of water being near.

"In our way over the plain, we fell in with an ostrich's nest, if so one may call a bare concavity scratched in the sand, six feet in diameter, surrounded by a trench equally shallow, and without the smallest trace of any materials, such as grass, leaves, or sticks, to give it a resemblance to the nests of other birds. The ostriches to which it belonged must have been at that time feeding at a great distance, or we should have seen them in so open a plain. The poor birds at their return would find that robbers had visited their home in their absence, for we carried off all their eggs. Within this hollow, and quite exposed, lay twenty-five of these gigantic eggs, and in the trench nine more, intended, as the Hottentots observe, as the first food of the twenty-five young ones. Those in the hollow being designed for incubation, may often prove useless to the traveller, *but the others on the outside will always be found fit for eating.*"

We learn from Vaillant, and other travellers, that this is always the use assigned to the supernumerary eggs by the natives of the country. Mr. Barrow, indeed, supposes that they are thrown out of the nest by the females, on their finding it to contain more than they can conveniently cover; but that is so contrary to all analogy, that I think it cannot be admitted. I believe that the supernumerary eggs are always found, and I cannot readily

think that the circumstance is accidental; for that an error can uniformly exist in any of the operations of nature, is abhorrent to every thing we know of her ways. Does the wild swan, or the goose, or the duck, ever lay more eggs than can be covered? do we ever find supernumerary eggs cast out of *their* nests? Surely not; but we can see no reason, if the thing be accidental with the ostrich, why the accident should not occur also with them and others. And farther, I would ask, why do the ostriches form a *trench* round the nest for receiving the extra eggs? Are we to consider this as a second mistake added to the first? In short, whether the use of these eggs be that assigned to them by the natives of Africa or not, it would be wrong to suppose that they are there by chance. We every where find design in the works of creation, and every thing tending to produce some good end; and I must still impress upon your mind, that any contradiction to this is only apparent, and that, did we understand its real nature, it would be found a perfection, in place of an error.

The nest of the wren, when placed in a situation such as I have supposed, is not easily detected; for its outside being composed of moss, it appears to be a mass of that substance. But if, instead of its being situated under the edge of a bank, or on an ivied trunk, we should find it fixed to some old oak or ash whose bark is clothed with grey or yellow lichens, its outside will then be seen to be formed of such lichens, and consequently it is equally difficult to distinguish as in the former instance, it being of the same colour as the body on which it is

placed. Let the circumstances, however, be reversed; let the nests change places, and it will be at once obvious, that the green nest placed on the grey oak, or the grey nest on the green bank or ivy, would in either case be a most glaring object, and the contrast would at once discover it to the eye of the prying schoolboy. Yet we can scarcely consider this as an example of instinct, but may refer it simply to the bird's making use of the substance nearest at hand. Montagu observes, "What is remarkable, the materials of the nest are generally adapted to the place: if built against the side of a hay-rick, it is composed of hay; if against the side of a tree covered with white moss, it is made of that material; and with green moss, if against a tree covered with the same, or in a bank. Thus instinct directs it for security. The lining is invariably feathers."

Mr. Jennings, however, in his very amusing book, "Ornithologia," observes, that the habit is not invariable, and that he has "known a wren's nest constructed of green moss at the edge of the *thatch* of a house, the colour of which was very different from the nest itself. Something," he properly remarks, "doubtless depends upon the ease or difficulty with which materials can be obtained."*

In the villages of the seà-coast of Antrim, it is a common practice to thatch the poorer houses with grass-wrack (Zostera *marina*), and I have often seen the wren's nest in the eaves of such houses, and formed of the thatch.

* Page 243.

Mr. Jennings observes, that he does not think Montagu's remark, that the lining is invariably feathers, is correct. "I believe," he says, "when made with *green* moss, its lining is generally of the same material." Now, if this be the case, it is a circumstance deserving of notice, as it shows that the bird instinctively knows how to regulate the softness of the bed for her young, by the degree of that quality which the material she employs may possess; if the material used be moss, she knows that it is soft enough, and if of hay or lichen, that it is not, and therefore she gives a lining of feathers.*

Let us consider our question; why is the wren's nest of large size and globular form? Simply, I presume, that it may be the warmer and drier. In an open nest the young would be too much exposed; and we may readily conceive that the little creature, which comes from an egg of only twenty grains in weight, is badly calculated to struggle against transitions of the weather. In the ingeniously built house we are considering, the little wrens enjoy a sufficiency of warmth; and from the thickness of its walls, for it is that which constitutes its chief bulk, are perfectly sheltered from rain, and also, perhaps, from enemies, by whom, in a more exposed nest, they might be destroyed. The advantages of this nest, too, are not limited to the period which requires the care of the mother. She

* In Mr. Rennie's Architecture of Birds, and in his edition of Montagu's Ornithological Dictionary, many interesting particulars respecting the wren's nest may be found.

begins to construct it as early as March, and you will readily conceive that the cold of the nights for some time after the young wrens have left it may be irksome or too great for them. The mansion, however, still remains, and it is the practice of the young birds, for a considerable time after they can fly and provide for themselves, to return at night, and sleep under the protection of its hospitable roof.*

The mode of proceeding in the act of constructing her nest is worthy your attention; it is thus described by Montagu: — "The wren does not begin the bottom of its nest first, which is usual in most birds, but first, as it were, traces the outline, if against a tree, which is of an oval shape, and by that means fastens it equally strong to all parts, and afterwards encloses the sides and top, leaving only a small hole near the top for entrance. If the nest is placed under a bank, the top is first begun, and well secured in some small cavity by which the fabric is suspended."

I have observed that it is by instinct, and not by any reasoning powers of her own, that the wren builds her nest, hatches her eggs, and rears her young; but do not suppose that I intend to inculcate the notion, that *all* the actions of animals are the result of instinct. Let no one convince you that man is the *only* being on this earth endowed with reason. He is infinitely more highly endowed with it, indeed, than any other; but I am sure no one is making use of that inestimable blessing when

* Selby.

he arrogates to his own species alone the entire possession of it. Never let your own pride, or the persuasions or the theories of others, blind you to the light of truth. Think for yourself, be enchained to no system, look to the operations of the Almighty in his works, and let nothing influence you to reject an item of the truth you there discover. Men have been too little accustomed to search and examine the real state of things, and then to found their opinions on the basis of observation and fact. Instead of studying nature, and seeing that every thing she exhibits has God for its author, they have too often formed theories of smoke and cobweb, blinding themselves and ensnaring others. They have supposed, in the folly of their hearts, that the world itself was formed by chance; that this globe, so beautifully diversified with hill and dale, and mountains and rivers, and all the varieties of scenery which are so delightful to the eye to behold and the mind to reflect upon, was struck off the sun by the chance blow of a comet, or that it was itself an extinguished sun, or that it was originally a fluid, and became gradually solid by the remains of animals and vegetables which had lived and died in it. Such and many more have been the absurdities of men, considered in their day as luminaries of science; and the nonsense itself has been held up to the admiration of mankind as the splendid fruit of genius. Thus it will always be, that when we leave the path of observation, and, in place of studying nature, give way to the suggestions of imagination, we must sink deep in the pit of error and folly. There are thousands of things which, in our present state of being, we shall never understand. In such

circumstances let us rest content in our ignorance; let us understand all that we possibly can; let us spare no trouble nor pains to acquire all the knowledge in our power, but let us be fully satisfied that all which we would dignify with the name of knowledge shall be strictly founded in truth. If we cannot come at the whole truth, let us be resolved to adopt nothing but the truth, however short of our wishes, and consider that a little wheat is better than a whole bushel of chaff.

And do we not shut our eyes to what is true, when we totally deny the existence of reason in other animals? Can any one read the history of the dog, or look at his actions, and not perceive (if he be not predetermined otherwise) that, in many things, he is guided by reason? Does the elephant not possess reason? nor the camel, nor the horse? I have seen many horses which appeared to me to have more sense than their brutal owners. Indeed, to consider animals as totally devoid of reason, is to consider them as mere machines, a sort of playthings, as it were, in the creation. Let us, however, take up Huber on bees and ants, and read the wonderful history of these insects as recorded by that acute naturalist, and fully verified by other observers, and then, if we are not fully resolved to deny, in spite of the most evident proofs, the existence of reason in those little creatures, we must deny the evidence of our senses if we refuse to admit it.

With respect to the wren, does not the following passage, taken from the "Journal of a Naturalist," prove that it is not altogether devoid of intelligence?

"*June* 14. I was much pleased this day, by detecting the stratagems of a common wren to conceal its nest from observation. It had formed a hollow space in the thatch, on the inside of my cow-shed, in which it had placed its nest by the side of a rafter, and finished it with its usual neatness; but lest the orifice of its cell should engage attention, it had negligently hung a ragged piece of moss on the straw-work, concealing the entrance, and apparently proceeding from the rafter; and so perfect was the deception, that I should not have noticed it, though tolerably observant of such things, had not the bird betrayed her secret and darted out. Now, from what operative cause did this stratagem proceed? Habit it was not — it seemed like an after-thought: danger was perceived, and the contrivance which a contemplative being would have provided was resorted to. The limits of instinct we cannot define: it appeared the reflection of reason. This procedure may be judged, perhaps, a trifling event to notice; but the ways and motives of creatures are so little understood, that any evidence which may assist our research should not be rejected. Call their actions as we may, they have the effect of reason; and loving all the manners and operations of these heaven-directed beings, I have noted this, simple as it may be." Surely this is an example of reasoning power, though it falls far short of what is observed in the bee and the ant. The wars, the stratagems, and other indications of intelligence in the latter, in fact so strongly resemble the transactions of human beings, that in reading its history we might almost suppose that it related to man himself.

LETTER VI.

Let us now suppose that we have ascended so high along the course of our little stream, that, instead of its winding softly through the bed of the valley, it is brawling down the mountain's slope, here and there pausing from its wild music and turbulent motion, as it glides over some little level space, which, as we usually observe, is found to break its rapidity before it descends to experience a new fall and to suffer more violent agitation. There is something peculiarly delightful in such a situation. Feelings occur there which no tongue can utter and no pen describe, but which, I think, all resolve themselves into the instinctive love of nature, which forms a part of our mental construction. The cliffs hanging over head, clothed with trees at the top, and with antique trunks of ivy creeping up their perpendicular and otherwise naked sides, with here and there a fissure or cavern opening its black jaws between them, contribute much to the picturesque beauty of the scene. Add to these the mossy verdure of the banks, and the intricacies of the nearly untrodden path between blocks of stone and rock, the evidences of former violence, when the now trifling current rushed with irresistible power down the ravine, and tore through every obstacle that opposed its terrific progress.

How different has the scene once been on the

spot where we stand from what it is now! Peace, and quiet, and smiling skies, and the song of the lark, and the gentle warble of the wind, are all here. The very gnat that plays in mazy dance on iridescent wings; that speck, as it were, in the creation, frolics in the air, as if exulting in its happiness. The ocean, which we left at the streamlet's mouth, now spreads its ample mirror far below, and seems to repose in the very lap of peace. The distant sail is an unmoving point in the horizon, a beacon, as it were, rising from the sea, and fixed for ever to the spot. That bark has measured, perhaps, the circumference of the wide globe, has often glided on the summer sea with a favouring breeze, and often laboured in the storm amid the raging elements, when the ocean and the air were one wide scene of uproar, majesty, sublimity, and danger. Now it lies on the flood impatient of the delay, not a ripple chafing its sides, and not a breath moving the canvass that hangs from the extended yards. But this will not continue long; before to-morrow's sun it may again feel the conflict of the waves, and again bound before the fury of the blast. And why is there this constant uncertainty of the winds and waves? The early poets speak of an endless spring; of gardens for the blessed, in which no changes of weather or climate shall alter the unvarying quiet and serenity of the scene. But to live in such circumstances would, I imagine, be to lead a life of listlessness, weariness, and stupor. One subjected to the fate of passing but a limited time in these gardens of ease, these scenes of quiet and repose, would get palled with the sameness, the inactivity, the want

of mental stimulus which must reign in such a state, and the mind would soon long for the changes, the uncertainties, the hopes, and the fears of our present being, rather than submit to the idle, stupid, dull, and senseless torpor of such an immortality. That broad and smiling sea, which now lies beneath us in such stillness and beauty, would in time lose its interest did it never alter; but one great characteristic of the works of the Deity is, that with endless beauty there is endless variety and change. The ocean is scarcely ever, even for one hour, the same; the morning breeze may sink into a mid-day calm, and that again may, before another day, be exchanged for the careering blast that is maddening the billows into foam, and dashing them in thunder on the leeward shore.

You should always recollect, that it is a most instructive exercise of the mind to think upon objects not only as isolated, but also in their connections and relations to nature as a whole. Let me, therefore, now turn your attention for a time to the element which composes our little streamlet and the wide-spread sea. Is it a simple substance? No, it is composed of two other bodies joined in chemical union. And what are they? The very opposite to what we might *à priori* imagine. They are two airs, and one of them is lighter than any air known; it is the lightest, indeed, of all ponderable substances. The one is oxygen, that part of the atmosphere which is absolutely necessary for the respiration of man and animals, whether they live in air or water. The other is hydrogen, or inflammable air, so named because it burns, and explodes

when a taper or flame of any kind is applied to it. Oxygen, however, is as necessary to combustion as it is to respiration, and hence the inflammable air will not burn unless oxygen be present. Now, observe this singular fact; these two gases form water by their combustion, and combustion itself is necessarily dependent on one of them, the oxygen, and yet water, the product of the combustion of the two, is among the most effectual agents we can use to extinguish fire. The torrent of rain which falls during a thunder-storm is formed, in a considerable degree, at the time, by the inflammatory explosion of these two gases, or airs, from their being ignited by the electric spark, or lightning, passing from one cloud to another. These subjects you will more fully comprehend when you get better acquainted with chemistry and natural philosophy; and as my present object is to steer clear of what is too abstruse or difficult to understand, I shall only advert to some of the more obvious and easily comprehended qualities with which water is endowed.

And how often, let me remark, have we cause to admire the simplicity with which the greatest results are brought about in the operations of nature! How different are the phenomena presented by water, simply from its being more or less in union with heat! Let it be cooled down to thirty-two degrees of Fahrenheit's thermometer, and what a metamorphosis does it undergo — so soft, so moveable, so penetrating, so liquid, so yielding as it is, it then becomes a solid mass, a block of ice; and, strange to say, though it has thus become solid, and has given out much caloric or heat, yet it has not be-

come heavier, but, what is still more remarkable, it has acquired greater levity. It is a general law, that bodies contract by cooling and expand by heating; but water is an exception to this rule: and why it is so let us enquire, for, you know, there must be a reason for it, as we have now done for ever, I hope, with the chimera of chance. Water, like other bodies, *does* contract by cooling, but only to a certain extent; when cooled to forty degrees of Fahrenheit's, it then begins to expand, and continues to do so down to thirty-two degrees, when it becomes ice, and in that state is more expanded still by the crystallised arrangement, which its particles assume. Suppose, now, that, like other bodies, it went on contracting in proportion to the quantity of heat lost, what would be the consequence? The ice, in place of swimming, would sink, and what then would be the condition of many of the most beautiful spots on the globe? The lakes of Cumberland and Killarney would then have little attraction for painters and poets, nor would the lovely scenery of Loch Lomond be explored by means of a pleasure steam-boat. The beds of these beautiful lakes would be choked with ice, which no summer sun could melt. But this would not be the extent of the evil; the fish and other inhabitants of the water would perish; the rivers, blocked up with the sunken masses of ice, which would accumulate, and cause the stream to overtop its banks, would inundate the countries through which they flow. Ice, as things are, often proves a formidable source of danger; it carries away bridges, and, in form of floating islands, en-

dangers ships; but these are trifling when compared with the ruin which it would have brought upon a large portion of the globe, had water not been invested by the Almighty with properties that break through those established laws of caloric by which other bodies are influenced.

The circumstance of ice floating is, moreover, a positive good, as it thereby protects the inhabitants of the water over which it is encrusted from suffering the extremes of cold which they otherwise would; for, like snow, it is a very bad conductor of heat, and consequently the water beneath, with the exception of its upper stratum, retains its ordinary temperature, and this upper colder stratum being expanded, floats on that below, and thus a mixture of the two is prevented. Though to some it might seem a little paradoxical, yet nothing is more true than that ice and snow are, in certain cases, the warmest of coverings. One might suppose that to dwell in a hut or house made of either would be almost the height of human misery and privation; and yet such is not found by experience, so long, at least, as the atmospheric temperature is not above freezing. The account given in Captain Parry's second voyage, of the snow huts of the Esquimaux, is sufficiently illustrative of this. During extremely cold weather these good people are comfortable enough in their dwellings; for however cold it may be on the *outside*, the frozen walls prevent the *inside* from being lower than thirty-two degrees. But when the severity of the winter abates, and the walls begin to melt, then they are subjected to colds, coughs, and

other inconveniences. Under date of Thursday, February 28th, 1822, Captain Parry observes of the inhabitants of a small village composed of five huts in Winter Island, that " almost the whole of these people were now affected with violent colds and coughs, occasioned by a considerable thawing that had lately taken place in their huts, so as to wet their clothes and bedding; though we had as yet experienced no great increase of temperature. From the nature of their habitations, however, their comfort was greater, and their chance of health better, when the cold was more severe. On this account they began to make fresh alterations in these curious dwelling-places, either by building the former apartments two or three feet higher, or adding others, that they might be less crowded. In building a higher hut they construct it over, and, as it were, concentric with the old one, which is then removed from within. It is curious to consider that in all these alterations, the object kept in view was *coolness*, and this in houses formed of snow !"

There is much more connected with the subject of water, which may serve as a useful occupation for you to consider, such as its universal diffusion in animals, plants, and minerals; the vast mass of it which forms the ocean, that medium by which the most distant nations communicate with each other; the saltness of the sea, which qualifies it to be the habitation of innumerable animals and plants which could not exist in fresh water; the tides, which, by keeping it in constant motion, prevent its becoming putrid; and the effect which its salt-

ness has in limiting the boundaries of the polar ice; for were the ocean composed of fresh water, the dominion of frost would extend much nearer the tropics than it does. When you further consider water under its forms of dew, of vapour, of steam, and all the wonders connected with the latter; when you think on the formation of the clouds, on the irresistible expansion of ice, on the laws by which fluids are governed; you must be satisfied that the consideration of water is no barren nor uninteresting employment of the thoughts. You will find, that had it been heavier, or lighter, or less moveable, or more elastic, it would not have answered the ends intended.

Here, then, though remote from human haunts, in a wild glen channelled down a lonely mountain's side, we find that matter for contemplation is not deficient. Where, indeed, can we go, and not find every thing full of instruction, if we but take the trouble to search for it? and what instruction can surpass that which makes us more intimate with the wisdom of the operations of nature, and shows us, that not from what is strange, or uncommon, or novel, only, is knowledge to be acquired, but that every object in existence contains an important lesson, the study of which, by giving us more enlarged views of the Deity, will ennoble our minds, and make us better as well as wiser men? Even this little stream that glides murmuring at our feet may, as you perceive, serve to raise our thoughts to the Source of all knowledge; but all the glories of nature may lie before us, and tell nothing, and teach nothing, if we do not give the

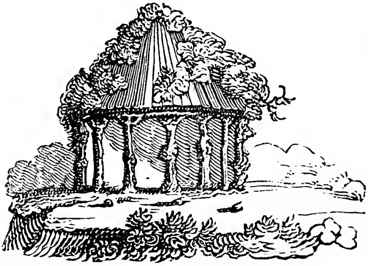
mind its natural bias, and search for the wisdom which they contain.

How little have the pleasures and resources to be found in solitude been comprehended! How many have retired into the shades of country life, thinking to find peace and happiness, when, in place of these, they have experienced only listlessness, languor, irritation of mind, and misery! How many, after making the trial, have left the rural retreat that was to form their easy transit from the troubles of this world to the happiness prepared for them in a future state, and again joined the bustle, the turmoil, the cares, and the anxieties of the life which they had left! But there is no true happiness where the mind is not in some way employed; and the citizen of a town, who, having made his fortune, retires to spend the rest of his life in the country, being cut off from his usual mental occupation, and not having other resources within himself, is, and must be, unhappy. The best cure for this is, I believe, the study of nature; I mean the practice I have been all along recommending to you, of looking at and considering her productions in reference to their Author. When a man is placed in a wild, or a romantic, or a rich piece of scenery, is he, with Zimmerman, to look for the "pleasures of solitude," by sitting down under a tree, and reading some work of human imagination, or a history of wars, battles, and court intrigues? This is nothing more than the solitude of a study, without its advantages. No: let him leave his book at home, and learn to read the great

volume of God that lies before him; let him look to the mountain, and reflect on the Power that heaved its huge bulk from the plain beneath; let him think of its strata, torn from their deep foundations in the earth, that they might become more accessible to his inspection; let him muse upon the rivers or streams which originate in the recesses of its bosom; let him learn the history of the eagle, that builds in its inaccessible cliffs. — But why need I particularise farther? What is there in earth, or air, or water, that does not abound in entertainment and instruction? Is it not extraordinary that this mighty fund of knowledge is so little drawn upon? How few have one idea upon the subject! Many, indeed, talk of nature, and think that when they repeat the cuckoo song they have been taught to utter, that "God has made every thing," they of course know all that is necessary, or desirable, or useful; but this miserable subterfuge is as if a person should state, that he was sufficiently acquainted with the contents of an Encyclopædia, because he could pronounce the name of its publisher. And yet these people will be highly offended, if an insinuation even be thrown out, that every thing visible and invisible has not been made solely for man's use? Were the vermin that prey upon him when he becomes subject to poverty and disease made for his use? Was the tape-worm made to serve him; or the hydatid that forms in his liver or brain, and destroys him? Was the chigoe made to benefit him? if so, how comes he to lose a leg or his life by the nest-

ling of that insect in his skin? Were the sand-fly, or the mosquito, and many others which torment him by their bites; or the serpent, which wounds and poisons him to death; or the scorpion, or the centipede; or the locust, which eats up the vegetation of whole countries, and causes him to die of famine by thousands; or the Hessian fly, which destroys his crops unseen; or the ship-worm, which honeycombs the bottoms of his vessels, and renders their state dangerous; or the white ant, that devours his furniture as its own lawful property (and I might go on long enough);—were these made to serve him? In one sense we may reply in the affirmative. It is very well, perhaps, when a person is making his dinner of fresh salmon, to say that the salmon was made for him to eat; but when a sailor falls overboard, and is devoured by a shark, if the latter could speak, might it not with as much truth say that the sailor was made for him to feed upon? Man owes every thing to his superior intelligence; and in this sense he may consider that every thing was made for him, because there is nothing in existence which he may not *mentally* apply to use — even the wild beast, or the fish that would devour him. But that every thing was made to add to his bodily conveniences, or comforts, or luxuries, is contradicted by every day's and every hour's experience. It may be gratifying to our vanity, or it may fill us with proud and arrogant ideas of ourselves, to look on man as the lord of this world, and to suppose that every thing which exists, exists only for him,

and for the purpose of contributing to his temporary conveniences and wants. The true way, however, of considering this matter, is to attribute all advantages which man possesses over other creatures to his superior intelligence. This, and this alone, gives him the superiority; and but for this he would be the most helpless animal on earth, if, indeed, he could exist at all.



LETTER VII.*

Every branch of science is useful to every other branch; and if a man be acquainted with various sciences, he will be able to bring a greater mental power to bear on any one, than if he wanted the others; and hence, I would recommend you to add to Natural History a knowledge also, as far as is in your power, of Natural Philosophy, Chemistry, Physiology, and such other subjects as lie within your reach. A knowledge of Physiology and Chemistry is particularly valuable to the naturalist: — it gives him a much wider range of thought in his lucubrations on the works of the creation, and expands his mind to a fuller comprehension of the ultimate ends intended by the Creator in many instances, than without this accessary knowledge he could have. When, for example, upon a fine spring day we walk into the country and see the process of committing the seed, which is to form the future harvest, to the bosom of the earth, we can seldom enjoy a more interesting prospect of nature and of human industry. The wild flowers are then beginning to appear, the birds carol from the yet leafless trees, and the lark, high in the

* This Letter, which was not contained in the first edition, is chiefly taken from an address which I delivered on the opening of the Belfast Museum, Nov. 1. 1831. — J. L. D.

heaven, quivering on rapid wing, pours out his exulting song — the sower stalks over the prepared ground, showers the seed-grain on the surface, and then, to use the words of Thomson, —

> "The harrow follows harsh, and shuts the scene."

But the scene does *not* so shut up to the scientific naturalist. He traces the steps which the seed passes through in its developement to the green and growing plant; and he may even make it a point, from which, as from a centre, he may expand his thoughts far and wide through the fields of creation. Without pretending to illustrate the germination of a seed in all its aspects and bearings, I will, as exemplifying the principle which I have laid down, that any one branch of science is better understood by having a knowledge of other branches, occupy your time a little with some observations and reflections on the growth of plants from their earliest or seed state.

On examining a fresh bean, or one that has been softened for some time in water, we observe, first, that its external part is a coat, skin, or husk, enveloping the rest of the seed. This coat is really double; but the outer layer or cuticle is extremely thin, and not easy to detect. We next perceive, on removing this husk, that the seed is not single, but formed of two parts, halves, or lobes, placed in juxtaposition, and only united at one small space near the larger end or base, where the *scar*, or *eye*, (or *hilum*, as it is technically called,) is placed.

The two lobes or halves of the bean are called

cotyledons; but, large as they are, they do not constitute the most essential part of the seed. The small portion, where the two lobes are joined, is that part, and is, in fact, the entire plant, with all its leaves and flowers complete, but compressed into the smallest bounds; and hence, if we removed this little portion, and then planted the rest, we might look in vain for the young bean to make its appearance: the seed would die and rot in the ground, but no green leaf would ever spring from it. This little part was named the *corculum* (which means little heart) by Linnæus, and is with equal, or, indeed, greater propriety, called the *embryo;* it being in truth the plant in its earliest state.

Let us now observe what takes place in a bean when planted in the earth. The first change is, that the lobes swell from the absorption of moisture, and at length the coat or husk bursts. The radicle, or young root, is next seen to push out and strike down into the soil; and when it has acquired a certain length, then the part which is to form the stem, leaves, and flowers begins to expand or grow also, and at length emerges into the light and air. This part is named the *plumule*, or plume.

In this process of germination or growth of a seed, you will remark that the radicle is always formed, or, to speak more correctly, is developed, before the plume; and you will easily recognise the wisdom of this arrangement: for, as the root is the organ by which the plant is to be nourished, the importance, or, indeed, the necessity of *its* being *first* called into action, must be apparent; and this being requisite, you cannot fail to appre-

ciate the consequence of which it is, that the constitution of the seed is such as to accomplish the object required. But the physiologist asks, — if the root be necessary to the growth of the plant, what is necessary to the growth of the *root* until *it* is able to provide for itself, and extract nutriment from the ground?

The kid, or the lamb, or the calf, is nourished until it can live by cropping herbage from a fountain of nutriment supplied by the mother; in other words, the milk. Has the young bean any such provision? Yes; and without that it could not be developed into the growing plant. The lobes of the seed perform to it the same office that is performed to the young animal by the udder.*

I have now to observe, that, however homogeneous and unorganised the seed-lobe may appear, it is nevertheless full of vessels, and these communicate with that part of the embryo plant which expands into the rootlet. When, therefore, the seed-lobes become swelled and succulent by the absorption of moisture, the farinaceous particles are, by some process which we cannot explain (but which has often been considered as a kind of fermentation), combined with the absorbed fluids, so as to form a vegetable milk, and this, being collected by innumerable vascular branchlets, is at length carried by one large trunk from each lobe into the rootlet, to the nourishment and growth of which its presence is necessary.

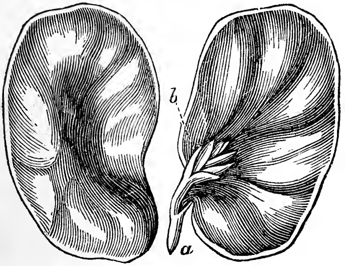
From this source, then, the rootlet is supplied with

* See Dr. Hunter, in his edition of Evelyn's Sylva, p. 33.

food; but the part which is to rise and form the green stem still continues of its original small dimensions, until the rootlet has attained sufficient strength and volume to extract and elaborate the moisture and nutritive particles from the soil. At length it does acquire sufficient maturity: it elaborates nourishing fluids, which now go to the plumule or plantlet; and it, in its turn, next expands and is developed into the green stalk and leaves, which raise themselves as they grow into the air and light. The seed-lobes having then done their duty, and acted the part of a bountiful nurse, die, and disappear. The plant is fully established in its own strength; it grows on, from day to day, to its destined form and dimensions; it flowers; it produces a numerous progeny of seeds, which continue the species: and thus, in this fugitive annual, we have a picture of the process by which man, in a more extended portion of time, though by a different organisation and economy, grows, flourishes, withers, dies, but still his race continues as before to people and inhabit the earth.

Figure 5., copied from Grew, will more clearly

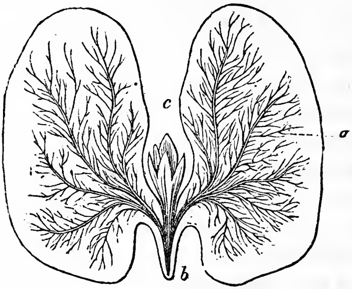
Fig. 5.



explain the remarks I have just made; and you here observe the beautiful arrangement by which the young plumule is protected in this tender state from the rough contact of the mould: you see that it is safely lodged between the seed-lobes, and is by them completely defended.

This next figure, 6., is a dissection to show the

Fig. 6.



ramification of the vessels in the seed-lobes, which convey the nutritive fluid, concocted in them, to the rootlet. It is rather, however, to be considered as a plan formed from various dissections, than as what could be shown at one time; but it is not the less true, as to the real structure. This ramification of vessels through the seed-lobes Grew named the *seminal root.*

The process I have now described may, perhaps, seem to be all that is necessary to be known respecting the germination of a seed: but let me impress upon your mind the conviction, that there is always something of importance in the phenomena presented by natural objects beyond what lies at the surface; and the process of germination, how-

ever admirable and perfect it may appear, so far as I have described it, will afford still farther, to the physiological student, matter for the deepest reflection. What is this principle of life which lies dormant in the seed till put into action by being placed in the earth? No man can tell; we know nothing of the real nature of life, either in animals or plants. It is one of the many mysterious things ever before us, yet which we only know so far as their phenomena are unfolded, but of whose ultimate or essential nature we have no conception. One thing relating to it, however, must, I believe, be admitted, namely, that life can only proceed from life; and whatever the principle, or rather whatever the unknown cause, of life may be, we know that it may long exist in an organised body without betraying itself; while in others, while equally unperceived, it soon dies, and cannot, by any art, be restored. A bulb found in the hand of an Egyptian mummy grew freely when brought to Europe, though it must have been several thousand years previously enclosed in the mummy-case. Some seeds will preserve their germinating, that is, their living power, for many years, as the bean: wheat, which is often found in mummy-cases, also grows freely; while others, as those of the coffee-tree, will not germinate unless they are planted soon after they have ripened. Why this is so we cannot tell. Some, again, germinate in a day or two, as occurs in those of garden cress; while others, as of the rose and hazel, require to be buried two years.

These, and many other phenomena connected with life, show that it is characterised by the

greatest variety; but they also show that the seed must possess its latent vitality, or it never will produce a new plant. The coffee-seed, if set when a year old, would produce nothing; it would not germinate, because it has lost its living essence, and life never can originate from a body that is dead. A dead seed can never give birth to a growing, that is, a living plant.

When a seed or grain of any kind, therefore, is planted or sown, do not imagine that it dies—it loses its appearance as a seed, indeed, but there is no death; it is converted into the future vegetable; and thus the life, or vital principle, infused by the Almighty into the first of the race which he created, is continued down from plant to plant, from animal to animal, and from age to age.

Perhaps the bean is not sufficiently demonstrative of these truths; and, therefore, I must give you farther evidence. Let us attend to a lupin. The seed-lobes of the bean, after they have sent the nutritive streams concocted in their vessels to the rootlet, remain in the ground, and as the plant increases they disappear. But the lupin is very different, since the seed-lobes in it, instead of thus remaining in the soil, rise above it, and are changed into *green leaves*. There is no death of the seed here, then, but there is a change; and though there is as little death in the bean, *that* is not altogether so evident as it is here.

In a large proportion of seeds the seed-lobes are evolved into leaves, which rise above the surface of the ground, and are, as I have already stated, called *seminal leaves*. I believe we owe their discovery

to the illustrious Grew. They are always of a shape different from that of the other leaves of the plant; and until the latter has gained strength enough to be nourished by the root, and to breathe air by its proper leaves, they are just as necessary to its existence and developement, as the seed-lobes are to the bean and other species which do not assume the change into green leaves. The farmer often experiences an important and serious proof of this, in the loss of his turnip crop, from this seminal or first pair of leaves being devoured by insects.

In the preceding letters I have dwelt, in a number of instances, on the perfection with which the designs of the Deity are accomplished; and, with the same view, let me ask, whether, so far as we have now gone with the germination of a seed, every thing is provided for that the case requires? The seed-lobes prepare the proper nutriment; the rootlet expands, and the plumule is next developed into the growing plant; but still something more is necessary to the perfection of the process, and that is, that the rootlet should have an uncontrollable propensity to penetrate into the earth, and the plumule an equally strong disposition to leave it: for, were there not this disposition in the constitution of the seed, it would, whenever it was planted or had fallen in a wrong direction, send the rootlet above ground, while the plumule would shoot under it, and the whole would, in consequence, perish. But, constituted as it is by its all-wise Creator, it matters not in what position it may be placed; the rootlet and the plumule always take their proper respective directions.

Paley, in the 20th Chapter of his Natural Theology, has the following excellent passage:—"When a grain of corn is cast into the ground, this is the change which takes place. From one end of the grain issues a green sprout; from the other a number of white fibrous threads. How can this be explained? Why not sprouts from both ends? Why not fibrous threads from both ends? To what is the difference to be referred but to design; to the different uses which the parts are thereafter to serve; uses which discover themselves in the sequel of the process? The sprout, or plumule, struggles into the air, and becomes the plant, of which, from the first, it contained the rudiments: the fibres shoot into the earth; and, thereby, both fix the plant to the ground, and collect nourishment from the soil for its support. Now, what is not a little remarkable, the parts issuing from the seed take their respective directions, into whatever position the seed itself happens to be cast. If the seed be thrown into the wrongest possible position,—that is, if the ends point in the ground the reverse of what they ought to do,—every thing, nevertheless, goes on right. The sprout, after being pushed down a little way, makes a bend, and turns upwards: the fibres, on the contrary, after shooting at first upwards, turn down. Of this extraordinary vegetable fact, an account has lately been attempted to be given. 'The plumule (it is said) is stimulated by the *air* into action, and elongates itself when it is thus most excited; the radicle is stimulated by *moisture*, and elongates itself when *it* is thus most excited. Whence one

of these grows upward in quest of its adopted object, and the other downward.' * Were this account better verified by experiment than it is, it only shifts the contrivance: it does not disprove the contrivance; it only removes it a little farther back. Who, to use our author's own language, '*adapted* the objects?' Who gave such a quality to these connate parts as to be susceptible of *different* 'stimulation;' as to be 'excited' each only by its own element, and precisely by that which the success of the vegetation requires? I say, 'which the success of the vegetation requires:' for the toil of the husbandman would have been in vain, his laborious and expensive preparation of the ground in vain, if the event must, after all, depend upon the position in which the scattered seed was sown. Not one seed out of a hundred would fall in a right direction."

In this passage there is one little mistake, though it does not affect the argument. The green sprout does *not* issue from one end, and the fibrous root from the other, but both grow, as in the bean, from the same point. When, however, we superficially examine a germinating grain, there is the *appearance* of a double origin of the plume and rootlet; and this, perhaps, is connected with a useful part of the economy of the process. We saw that, in the growing bean, the plumule lies for a certain time enclosed between the seed-lobes, and is therefore safe until it has strength enough to bear the contact of the rough mould. Now, the *husk* of the grain seems to me to answer, in this respect,

* Darwin's Phytologia, p. 144.

the purpose of a second seed-lobe; the plume and radicle protrude from one end, but the former passes between the seed-lobe and the husk till it reaches the other end, and then it protrudes itself into the soil. Hence, though the appearance of a germinating grain is that of the green leaf springing from one end, and the root from the other; yet, when we strip the husk off, it is found that both have sprung from the same end, but the leaf had passed under the husk, protected from the soil till it reached the opposite point.

Now, is not this common process, this growth of a seed, a most admirable proof, first of Divine wisdom, and next of Divine power? Suppose, for a moment, that seeds had *not* the useful propensity here adverted to, we should then readily appreciate the vast advantage which would result *could* the grain be but invested with it; but no human power could give the propensity; no being but the Almighty could endue the seed with this uncontrollable disposition to erect the one part into air, and sink the other into earth; and, therefore, even in this so common process, we perceive the wisdom, the power, and the goodness of God; — his wisdom to contrive, his power to complete the contrivance, and his benevolence in so doing.

Why the seed-lobes of some plants should remain concealed in the ground, and those of others rise in the form of seed-leaves, we do not know. Neither, I believe, can it be explained why some seeds have only one cotyledon, some two, and others more than two, as in the pine tribe.

In taking a spring walk, you will find consider-

able pleasure in marking the various appearances which the first, or seminal, leaves of plants present. They are always, as I have said, different from the others, on which account Grew called them *dissimilar leaves;* and we may here observe the direction and ramification of the seminal root; for the branching fibres, seen by holding these leaves up to the light, are those of the seminal root as they existed in the seed-lobe, but are now apparent by their greater development.*

Among other reflections which may occur to you in these examinations, I would have you to think of the mutual connection which exists between the different parts of nature, and the dependence which all living beings, whether animal or vegetable, have upon circumstances external to themselves. Without water, neither animal nor plant could exist; light is almost as necessary; heat also; and, perhaps, electricity; and, it may be, several unknown influences or elements, as yet too subtle for our researches to detect; while air is more immediately necessary for both animal and vegetable life than food itself.

And here we see, how to destroy the seminal leaves is equivalent to destroying the whole plant, — they are now its organs of breathing, its lungs; and, when their function is cut off, the plant dies, as much from want of air as an animal does when it is drowned, or otherwise dies by suffocation.

And why is this air so necessary to animal and vegetable life? No one can tell; we merely know

* See Grew's Anatomy of Plants, page 10. last paragraph.

the fact, that it is so, and we know no more upon the subject, so far as the ultimate object is concerned. It is ascertained, indeed, that oxygen is the ingredient, in its composition, on which life is dependent; but it is ascertained also, that pure oxygen gas, breathed alone, is too stimulant, and that animals soon die in it; and this knowledge gives us another insight into the wisdom of the Deity; for, had not the oxygen of the air we breathe been mixed or diluted with another kind of air of a passive nature, life could not have been sustained by it.

Oil of vitriol is, you know, a strong corrosive poison, and a small quantity of it swallowed, in its concentrated or pure state, would prove fatal; but you know also, that when diluted, and consequently weakened by the addition of a large quantity of water, it can not only be swallowed, but is a pleasant drink, and an efficacious strengthener of the stomach. Now the atmosphere forms a parallel case; the oxygen is too strong by itself, but every twenty parts of it being diluted with eighty parts of nitrogen or azotic gas, the mixture forms the mild and grateful air on which our life depends from the first breath that is drawn, till the last, when life and respiration cease together. There are many gases which, like nitrogen, are unfit for respiration, when not mixed with oxygen; but none could so well have answered the purpose of combining with it to form an atmosphere; and, though its utility depends on its negative properties, yet it may be considered almost equally necessary to animal life, as the more active oxygen with which it is combined.

It appears to be every day more and more evident, that the deeper we get into scientific discovery, the stronger and stronger proofs do we find of the divine wisdom and power; and in the composition of the atmosphere (which is a discovery of comparatively modern times), we perceive these to be very strongly marked. There is every reason to believe, that had the oxygen and nitrogen been mixed together in any other proportions than they are, the atmosphere would not have been proper for the support of animal life; and compounds, of the most deadly nature, are, we know, formed, by chemically combining these airs together in different quantities; as for example, the air called nitrous acid gas, which consists of four proportionals of oxygen, and one of nitrogen, so far from being of a salutary nature, is instantly fatal to any animal that inhales it; and the nitric acid, or aqua fortis of commerce, is formed by chemically combining other proportions of oxygen and nitrogen. These, however, are chemical compounds, but the gases of the atmosphere are simply mixed together, and not in chemical union.

Another important result of the oxygen of the atmosphere being diluted with nitrogen is, that the activity of combustion is kept down by it. Any burning substance put into nitrogen is instantly extinguished; but the same ignited substance plunged into oxygen burns with a fury and brilliancy, of which those who have not seen the experiment could have no conception. Were the atmosphere composed of oxygen alone, the spark from a flint would risk setting fire to the globe itself.

The air contains, also, a little water, and a very small quantity of carbonic acid, but the mixture of oxygen and azote we are to consider as *the* atmosphere; — and of what moment, what importance, is it in the great economy of nature! We set the highest value on gold, on silver, on pearls, on precious stones; but what are these but the merest baubles, compared with that beneficent aërial fountain of life which is breathed by every organised being; by every man, quadruped, bird, reptile, fish, insect, animalcule, tree, shrub, herb, and vegetable form, however large or minute, on the whole extent of this earthly orb.

And what would the earth have been, had it been formed in every respect as it is, but *without* an atmosphere? It might have continued to roll on its orbit, and perform its diurnal revolutions as at present; but what a blank would its surface be, compared with that which it now exhibits? It would be one wide scene of desolation, or at least of destitution, and an imperturbable death-like silence would reign over all its ample bounds; — all would be a dead, sterile, naked wilderness. No eye would see the alternate change of light and darkness; no voice of congratulation would hail the dawning morn, or view with delight the varied hues of the declining day. No forests would wave to the breeze; no pine would crown the mountain rock, nor shrub nor herb adorn the valley or the river's bank. No sounds would fill the empty void; — the ocean flood would sweep on in silence; for without air, there can be no sound: — neither animal nor plant could inhabit the dreary domain; for, without

air, no animal nor plant can live. The dead region would possess no trace of the forming hand of Deity, in those mighty examples of his power, wisdom, and beneficence, the organised kingdoms of nature.

Thus lifeless, barren, destitute, would have been this earthly ball which we inhabit, and which, as it is, forms so glorious a contrast to what we may conceive to be the state of a world ungifted with an atmosphere. Instead of a picture of inanity and desolation, how different are its present circumstances! How numerous the species of vegetables; how various their forms and colours; how important their uses; how ample the green envelope with which they at once clothe and beautify the globe; how infinite the examples they offer to us of divine workmanship and inscrutable wisdom!

And with respect to animals, of which *we* are at the head, how vast is the instruction to be found in their history and organisation! It may be said, indeed, that God could, if he pleased, have made animals and plants to live *without* an atmosphere; but we have nothing to do with that: — it is sufficiently obvious, that man, animals, and plants could not, constructed as they are, have existed in *this* world without oxygen. Respiration is a necessary and unavoidable function attached to our being. We cannot live unless we breathe; and whatever may be the constitution of the inhabitants of other worlds, and whatever may be the laws to which they are subjected, the breathing of air in this is absolutely necessary to our existence.

LETTER VIII.

However much it may be the custom of some writers of the present day to disparage the Linnæan system of Botany, it certainly is, I think, of more use to a beginner than any other that has ever been invented. In fact, for all practical purposes, it excels every other. It has its imperfections, no doubt, and so has every system that ever has been or ever will be formed; but on the whole, for the purpose of leading the student pleasantly and with comparative ease to a knowledge of plants, there is none to be compared with it. I would recommend you to commence your botanical pursuits by studying the wild plants which are the growth of your native place: and do not content yourself with getting merely their names; compare, minutely, every plant you examine, with the description given of it in the best Floras of the country, some of which are named below.* To know a plant at sight, and be able to state its scientific appellation, many consider as constituting the great object of botanical learning; but you might just as well suppose, that to know the names of men and

* Withering's Arrangement of British Plants, seventh edition; Smith's English Flora; Greville's Flora Edinensis; Hooker's Flora Scotica; Hull's British Flora; Purton's Midland Flora. To these many more might be added, if necessary.

women, so that you could say, "That is Mr. such a one," and "This is Mrs. such another," without knowing any thing farther about them, was to have a knowledge of them. You must not stop at that limit. It is a very essential step, indeed; for unless you first learn the name of a thing, you cannot easily get information respecting it; and this is the great use of the Linnæan system to the student, — it leads him to the name: but having found that (which is done by referring the plant successively to its class, order, genus, and species), you must enquire into its history, learn its uses (if it *have* any known use), whether in agriculture, diet, manufacture, or the arts; and for these, consult works of modern or recent date, for the old herbals abound in endless trash and nonsense. In fact, plants were formerly attended to almost entirely with a reference to the shop of the apothecary; and so many virtues were attributed to them, that, were they real, the practice of physic might, without any impropriety, be handed over *in toto* to the old women. Medicinal herbs, or, in other words, all vegetables then known, were called simples; and when a man went out to collect plants, he was said to have gone "a simpling." Were I to quote for your amusement but a very few of the absurdities contained in any of the old writers, you might be inclined to think the term would have applied in another sense: but you must recollect that knowledge is progressive; and had we lived in those days, we should, I presume, have been not a bit wiser nor less simple than our neighbours. The great bar to improvement in all ages has been the fondness for

theory, or rather, I should say, the adoption of opinions without evidence of their being founded in truth; but the time is coming, I hope, when nothing in science will be positively received, the truth of which cannot be proved by strict observation and experiment.

While I recommend that you should learn the economical and other uses of plants, you are not to conceive that I look upon these as the chief end to be attained in their study; neither do I consider the perfect knowledge of any system the great object. Both are of high importance, and both indispensable to the accomplished naturalist; and admitting this, I do not see why botany should be studied as a science unconnected, as it so often is, with the various properties and uses of plants. If a species have useful qualities, why are these to be neglected? If a tree produce a valuable secretion, as gum, or Indian rubber, or camphor, are we to think nothing of such secretion, and hold the scientific arrangement or classification of the tree to be the only or chief object deserving our attention or consideration? If we wish merely to be scientific botanists, such may be the case; but I think one great view, which every man who has time and capacity at the present day should entertain, is to combine science with useful knowledge, and to spread both as far as he can. These cannot be made too easy, and they ought, if possible, to be given in such a dress as to prove attractive and delightful to every man who can read and write. This never will be the case with dry details, however ingenious or perfect the system may be to

which they relate; and hence, notwithstanding the great progress of science, as such, comparatively little taste for it has as yet spread among the people at large. Much, no doubt, will be accomplished by the exertions of the "Society for the Diffusion of Useful Knowledge;" but the full accomplishment of what could be wished in this respect will never happen, till sufficient means are used to make people consider the phenomena and laws of nature, with a frequent reference to their Contriver and Creator; in a word, till they are taught to cultivate natural religion, — a thing of which the public in general know as little as of the terra incognita.

After this digression, let me make some observations on a few common plants, with which you cannot but be acquainted. Why is it that every one is pleased with the common ivy? There is a charm about that plant which all feel, but none can tell why. Observe it hanging from the arch of some old bridge, and consider the degree of interest it gives to that object. The bridge itself may be beautifully situated; the stream passing through its arches clear and copious; but still it is the *ivy* which gives the finish and picturesque effect. Mouldering towers, and castles, and ruined cloisters, interest our feelings in a great degree more or less by the circumstance of their being covered or not by the ivy. Precipices, which else would exhibit only their naked, barren walls, are clothed by it in a rich and beautiful vesture. Old trees, whose trunks it surrounds, assume a great variety of aspect; and, indeed, it is a most important agent in forming the beauty and variety of rural

landscape. It is also as useful as it is beautiful; and among its uses I would include the very thing of which I am now speaking, for I have no idea that the forms and colours in nature please the eye by a sort of chance. If I admire the ivy clinging to and surmounting some time-worn tower, and the various tints that diversify the parts of the ruin not hidden by it, I can only refer the pleasure I experience to the natural construction of the human mind, which the Almighty has formed to feel a pleasure in contemplating the external world around it. Who is insensible to the beauties of nature at the rising and setting of the summer's sun? Who can behold the moonbeams reflected from some silent river, lake, or sea, and not feel happy in the sight? None, I believe, in early life. When hardened in the ways of men — when the chief good pursued is the accumulation of wealth, the acquisition of power, or the pursuit of pleasure, so called, — then mankind lose a sense of the beauties of nature; but never, perhaps, till then. A love for them is inherent in the mind, and almost always shows itself in youth; and if cherished at that period by education, would seldom be destroyed or become dormant in after-life, as it now so generally is.

The ivy is of vast advantage to the smaller birds, as it affords them shelter in winter, and a retreat for building their nests in spring and summer. It is in fructification in October and November; and the sweet juice which its flowers exude supports an infinity of insects in autumn, while its berries are a store of nutriment for many

birds in the early spring. Along with other excellent observations relating to this plant, you will find the following in the "Journal of a Naturalist," 2d ed. p. 85: — "Those two extreme quarters of our year, autumn and spring, yield to most animals but a very slender and precarious supply of food; but the ivy in those periods saves many from want and death; and the peculiar situations in which it prefers to flourish, are essential to the preservation of this supply, as in less sheltered ones it would be destroyed. In the month of October the ivy blooms in profusion; and spreading over the warm side of some neglected wall, or the sunny bark of the broad ash on the bank, its flowers become a universal banquet to the insect race. The great black fly, and its numerous tribe, with multitudes of small winged creatures, resort to them; and there we see those beautiful animals, the latest birth of the year, the admiral and peacock butterflies, hanging with expanded wings like open flowers themselves, enjoying the sunny gleam, and feeding on the sweet liquor that distils from the nectary of this plant. As this honey is produced in succession by the early or later expansion of the bud, it yields a constant supply of food till the frosts of November destroy the insects, or drive them to their winter retreats. Spring arrives; and in the bitter months of March, April, and even May, at times, when the wild products of the field are nearly consumed, the ivy ripens its berries, and then almost entirely constitutes the food of the missel-thrush, wood-pigeon, and some other birds; and now these shy and wary birds, that commonly avoid the haunts of man,

constrained by hunger, will approach our dwellings to feed upon the ripe berries of the ivy: now, too, the blackbird and the thrush resort to its cover, to conceal their nests. These early-building birds find little foliage at this period sufficient to hide their habitations; and did not the ivy lend its aid to preserve them, — and no great number are preserved, — perhaps few nests would be hidden from the young eyes that seek them. The early expansion of the catkins of the sallow, and others of the willow tribe, whence the bee extracts its first food, and the late blooming of the ivy, are indispensable provisions for the existence of many of the insect race."

Now, only recollect how often you have seen the ivy in October, and the bloom of the sallow in April, without ever asking yourself *why* the one flowered so late, and the other so early. This is another example of the want of attention paid to things to which people have always been accustomed. Were a tulip to blow in the open air in November, or a white lily in April, the whole country round would flock to the wonderful sight; but the thousand examples of divine wisdom and arrangement that are daily passing before our eyes are neglected or despised.

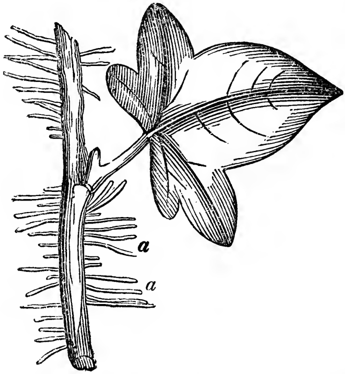
Let us enquire, whether the tendency of ivy to climb is a wise provision. If one great use of the plant in the economy of nature be the protection of animals, would the purpose not have been equally answered by an evergreen tree springing at once from the ground, and bearing branches like other trees? No; because the shelter afforded by ivy,

growing as it does around trunks, and on walls and rocks, is much more perfect and secure than could be attained, perhaps, in any other way. But a question arises; — Does it injure those trees and walls to which it is attached? This I cannot answer from my own observation; but a very intelligent and observing friend has informed me, that he is in the practice of encouraging the growth of ivy on his trees, and that he has no fear of its injuring them. This, however, is not proof sufficient. That it is not injurious to walls, I have had repeated assurance from persons who spoke from their own practical experience. When sufficiently old, so as to cover a wall, it protects it both from sun and rain; and do we not every where see, that the part of a ruin best preserved, is that which the ivy covers? It may serve, too, as a substitute for a part which time has nearly removed, as was remarked to me by the friend above alluded to. "Had it not been for the ivy," said he, "that summer house" (directing my attention to a little square building, of which scarcely a stone could be seen through its verdant envelope) "would many years ago have been roofless and dilapidated; the ivy has saved it from destruction."

Were the sight not so familiar, we should find some difficulty in conceiving how a plant of such large dimensions could climb up and adhere to a steep wall or rock. It does so by sending out a number of claws, or root-like projections, which insinuate themselves into the pores of the body it ascends; and by them it is kept fixed. It appears that these claws keep their hold by swelling, so as

completely to fill the pores; though some have thought that atmospheric pressure was the chief agent of adhesion. Does the ivy, you may ask, shoot out these claws at random? Not when it is of material consequence that they should proceed from one side only; and hence in the *young* ivy we find that they shoot only from the side that is applied to the tree or wall. If you examine a young ivy branch climbing up the smooth bark of a beech, you will find that its claws go out in great numbers from each side, and spread horizontally (*fig.* 5. *a*); and in tearing it off you will bring

Fig. 5.

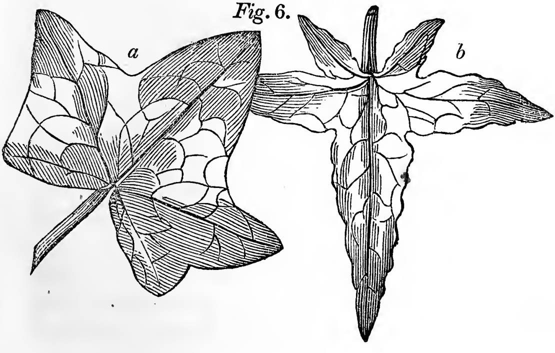


portions of the epidermis, or outer layer of the bark, adhering to them. It is evident that on a smooth bark this direction must be the most effectual in fixing them to the part, but if the latter be rough and chinky, then you will observe that the claws in general run perpendicularly into the

fissures, and do not spread out sideways, which in this case would not be so effectual. When the ivy is old enough to have a trunk, then the claws shoot out from the latter, and its larger branches on all sides, so as to render it rough, and as if clothed in bristles; but we never see this in the young state.

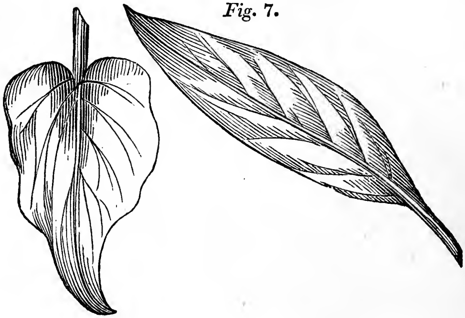
Through the medium of these claws, the ivy ascends to a great height; it will mount the highest castle or tower, and wave triumphant on its summit; and yet, though it climbs the trunks of very high trees, we do not find that it ascends far upon the branches. If it did so, it would injure the tree very materially, or destroy it, by choking its leaves. Have you ever remarked how the shape of the ivy-leaf varies according to its situation? It differs greatly according to circumstances, and I apprehend that the variations are connected with a very curious and important part of the economy of the plant. The leaf of the young ivy is pentangular, or five angled (*fig.* 6. *a*), sometimes like (*b*), and

Fig. 6.



while the plant is climbing, it is almost invariably of this form. But if a branch project from the stem, and hang out free from the tree or wall, you will find that the leaves of such branch are ovate or lanceolate (*fig.* 7.), and also, that on the branch itself there is no appearance of claws.

Fig. 7.

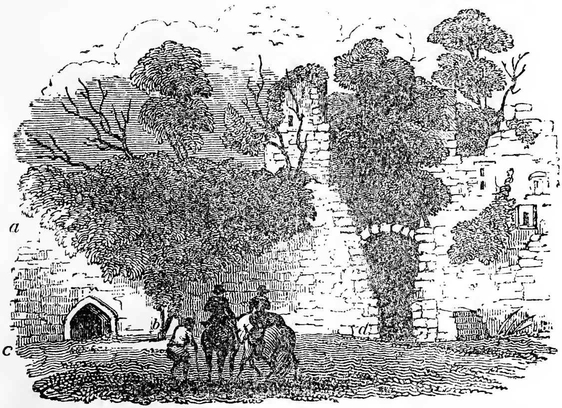


Since I commenced the present letter, I have paid considerable attention to this plant, and on examining it on the wall of the Cave-hill deer-park*, which is about nine feet high, I observed the generally well known fact, that the leaves were all pentangular, until it had mounted very near the top of the wall, and then numbers of them had become exactly heart-shaped, while all those on the branches that had surmounted the wall were ovate or lance-shaped. I had long before remarked what I consider a curious circumstance, which is, that although ivy produces its berries in very great abundance, and each berry contains five seeds, yet

* Near Belfast.

one single plant seems to usurp the complete possession of a large portion of wall, to the exclusion of any other plant of the same kind growing in its vicinity. The most remarkable examples of this, with which I am acquainted, occur on that noble ruin, the castle of Rothsay in Bute. The following sketch of (*fig.* 8.) part of the court-yard of that place will

Fig. 8.



illustrate my meaning: *a* is a very large ivy tree, spreading from one trunk (*b*) along a great extent of wall; and though it must, I should suppose, produce many thousand berries every year, yet there is no appearance of an ivy plant growing under all the space *c d*. This is very remarkable at the Cave-hill deer-park, where often one plant is lord of the wall for a great extent, without any appearance of others of the same species presuming to spring up near it.

The trees in the above sketch, which rise above the wall to a considerable height, are ashes, which have taken root there; but it is not the habit of the ivy to shoot far above the summit of the object up which it has clambered. When an ivy trunk has got fair possession of a wall, its branches diverge from it somewhat in manner of the spokes of a fan; and when they have reached the top of the wall, they creep along it laterally, forming innumerable twistings and overlappings, by which the whole are bound together in the strongest manner; and the branches, which rise up and bear the flowers and fruit, are, in general, rather lateral ramifications than the continuations of the stem. They do not overtop the wall more than two or three feet; for the economy of the plant seems to be altered whenever it has got on so far as to stand no longer *in need of its claws.* Its whole powers then seem to bear on the ultimate object, the production of seeds; and when it is arrived at the top of the wall, a higher elevation is unnecessary. It is the same circumstance, I believe, that limits the growth of the plant, in a great measure, to the *trunk and part of the larger branches of the tree.* When it has got so high, the formation of claws and tendency to climb cease, and the branches produce flowers succeeded by berries. In the adhesion of ivy to rocks and walls, the frequent overlapping of its branches serves most materially to strengthen its hold; and we observe innumerable young branches, not climbing up in the direction of the parent trunks, but crossing and twining over them in all possible ways, transversely and obliquely, and tying them down as

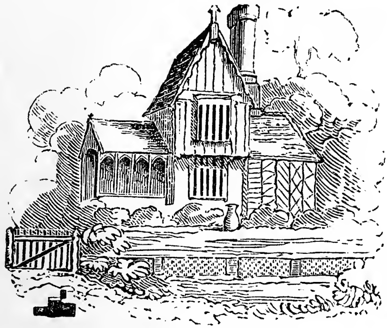
with strings or cords to the surface on which they are placed. This is still more evident in trees, where we find the young shoots of the ivy often forming rings round the trunks and thicker branches, like so many girths or braces. The intertwinings of the branches, and their serpentine direction, often bear a very exact resemblance to the distribution of blood-vessels in some parts of the animal body; and I have remarked a circumstance still more curious, that, whenever the branches which cross each other have become as thick as one's little finger, they grow together at the points of contact, so as to become perfectly consolidated with each other. This is still more striking in the larger branches; and you will often, on observing the trunk of an ivy bush, find that it is composed of a congeries of smaller stems, which have all grown together into one mass, and formed what, without examination, would seem to be one simple, uncompounded trunk.

It would be tedious to dwell longer on the ivy; the observations I have made respecting it may possess less interest than is attached to the history of many other plants; but I would rather that you should at present have a theme, however limited, for contemplation in things which are common, and which you have known from childhood, than in matters of much higher consequence, but which you could only have a knowledge of by hearsay. And let me again assure you, that the habit of contemplating nature is an inestimable and endless source of happiness. You have not yet lost the love of her, which is originally implanted, I believe,

by the Creator in every human bosom, though, as things are, it is almost always crushed and kept down by ignorance of its value, and a vicious and erring system of education. In early life, when we are the children of nature more than of art, all the works of God which we hear or see are sources of pleasure. The gurgle or music of flowing waters, the green tints of sloping banks enamelled with blossoms, the shadows of the flitting clouds, the waving of ferns and other foliage pendent from the cliff, the song of birds and hum of bees, the grey rocks, the mountains, woods, rivers, and lakes, — all speak to the instinctive bias within, and an undefinable pleasure is the result; though, perhaps, the causes of this may not at the time be suspected. In after-life we may be too wise, perhaps, to be influenced by such trifles; yet we cannot divest ourselves of a delightful feeling, when we think of the times when, in boyhood, we were conversant with nature. We *may* say, indeed, that the pleasures then felt arose from the weakness and inexperience of youth; but still we recall their memory with a melancholy gratification, and to enjoy the same happiness we would almost willingly be weak and inexperienced again.

As we ascend higher in the ravine, we observe some changes in the vegetation. The mosses are more numerous, the woodroof becomes plentiful; the heath-pea shows its beautiful blossoms; the rein-deer lichen clothes the tops of banks with its hoary and coral-like tufts; the polypody; the oak-fern; that most beautiful little plant the maiden-hair fern, and many more species, afford us ample

variety, and speak on every side the goodness of God, while they display the beautiful workmanship of his hand. Still ascending, we arrive at a cascade, where the water rolls from a height of above thirty feet down the face of a jutting cliff, which is flanked obliquely on each side by huge walls of rock. The summits of these are crowned with oak and ash trees; and from the cracks and fissures in the sides, a number of tortuous old trunks spring out, which, with the ivy and other vegetable tracery, give an indescribable interest to the scene. The repose which reigns in this place is not disturbed, but is rather rendered deeper, by the incessant sound of the falling water; which comes down as white as the drifted snow, and for ever boils, and foams, and bubbles in the deep dark basin which receives it.



LETTER IX.

On returning from our walk, which I fear you have by this time found but too tedious, we shall attend a little to some of the minuter productions of organised nature. There is, perhaps, no error more common than to consider objects as unworthy of attention because they are small; and, indeed, both the great and the little vulgar generally set a value on things so far only as they can be made subservient to temporal, ordinary, or selfish purposes. If money can be made by them, or if they can be eaten, or if they be useful in any manufacture, then they are considered as of some value; but if none of these uses are apparent, they are looked on as worthless, and beneath a wise man's notice. Yet this is to think as a fool; for it is in the minuter parts of creation that the works of the Almighty proclaim most clearly to us the wonders of his hand, and that man cannot be entitled to the appellation of wise who dares to contemn or asperse them.

What is the reason that the pursuits of the naturalist are so often turned into derision? If a man study mineralogy, he has some chance of not being thought to waste his time, for he may discover mines or quarries that will bring golden profit; but he who studies the structure of mosses, who collects sea-weeds, who paints fungi, who gathers shells, who examines flowers, or who hunts after insects, is, by a very large portion of his brethren, con-

sidered as little better than an idiot. The reason is this: few men have any ideas of natural religion. An erroneous notion seems to me to prevail with respect to natural theology, which is, that the chief use of it is thought to be to prove the *existence* of God. The excellent works of Ray, Derham, and Paley, generally speaking, have this for their chief object; but to me it appears that to stop there, is to stop, in a manner, where we should only be commencing. No man doubts his existence, — no man, at least, who has any ordinary quantum of intelligence, candour, and sense; and if any one do, he needs not remain long in uncertainty, for he may every where find proof, matter of fact, not dubious glimmerings, or opinions merely, or fabrications of men, but absolute, positive evidence, in ten thousand different shapes, of his existence, his power, his benevolence, his wisdom. But, as I before stated to you, his works are considered only as matters of course; they are not enquired into; men are often taught to despise rather than to study them; and when they are studied, the object in view is not natural religion.

I grant you that nature, however studied, affords a very delightful occupation. When a man of science collects plants for his herbarium, or minerals or animals for his cabinet, he experiences, unquestionably, much pleasure in such pursuit; but I contend that the habit of constantly referring to their Creator, of never seeing the work without thinking of its Maker, gives a heart and soul to the occupation, without which it is comparatively "flat and unprofitable." Suppose not, however, that in

this observation I mean to reflect in the slightest degree upon the labours of systematic naturalists. We ought to be grateful for every advance that has been made in any department of useful knowledge; and to no class of men are we more indebted on this score than to them. But still something is wanted to make natural history more generally respected, and more popularly understood, than systems or minute scientific arrangements, however perfect, ever can cause it to be. Nature, also, must be considered as a whole, and not studied, as is so often done by naturalists, in isolated parts, while the rest is neglected. Thus, one man studies the manners and history of birds, another devotes himself to the study of plants, another to that of shells, another to that of insects, without caring for any branch of natural history except the peculiar one which chance or choice may have made him select. Now, it is true that this has its use, and a most important use; for if a man give his undivided attention to one branch, there is a much greater probability of his bringing it nearer to perfection, and of making discoveries in it, than if his attention were directed to a multiplicity of subjects. For the general student, however, or for the people at large, this is not the plan that can prove most useful. What, in fact, is the great end of studying nature at all, but to attain to a knowledge of the Almighty as exemplified in his works? and until people discover that this is the legitimate and true object of natural history, it will never obtain the general consideration it deserves.

How vast is the variety of forms under which

organised nature exists! How endless the number of animals and plants that people and adorn the globe! Day after day brings us acquainted with species hitherto unknown; and it seems as if the door of discovery is never to be closed. Whenever a new country is visited, animals and plants, different from what had before either been known or imagined, are discovered: but how many regions will remain to be explored in that as yet almost unknown country which belongs to the microscope, after every spot of the earth shall have been described and laid down accurately in the map! So far as we have gone, the microscopic world is sufficiently astonishing; and had not scientific research produced the microscope, who could have believed that thousands of living creatures could inhabit a drop of water small enough to hang on the point of a needle? I think that above four hundred species of animalcules, invisible to the naked eye, have been discovered; but is it not probable that thousands upon thousands, as yet unknown to us, exist in the world, equally interesting, did we know their history and manners, as those of many which require no magnifying glass to observe them? Since the bee and the ant, notwithstanding their smallness, exhibit striking marks of intelligence, is there not a possibility that even the animalcules which are invisible to the unassisted eye may possess instinct, or a degree of rationality? Our observation is too limited to afford an answer; but there is certainly no palpable absurdity in the supposition. Who will assert that the Framer of the universe cannot endue the smallest particle of matter with intelligence

as well as life? The latter is to us equally mysterious and inexplicable as the former; and where we find the one, we may easily conceive the presence of the other. More extensive and repeated observation will be necessary to illustrate this subject, either as to its truth or falsity; and, in the mean time, the following statement, which you will find in Adams's work on the Microscope, will not be irrelevant. It relates to the hair-like animalcule of Baker, a species invisible to the naked eye, and "so small that millions of millions might be contained in an inch square." It is gregarious, or fond of associating with others of its kind, and is seen in parcels of from seven to forty. If a multitude are put in a jar of water, they will form themselves into a regular body, and ascend slowly to the top; there, after some time, their green colour changes to a beautiful sky-blue. When weary of this situation they form themselves into a kind of rope, which gradually descends as low as they intend.

"A small quantity of the water containing these creatures having been put into a jar of water, it so happened that one part went down immediately to the bottom, whilst the other continued floating at the top. After some time, each of these swarms of animalcula began to grow weary of its situation, and had a mind to change its quarters. Both armies, therefore, set out at the same time, the one proceeding upwards, and the other downwards; so that, after some hours' journey, they met in the middle. A desire of knowing how they would behave on this occasion engaged the observer to watch them carefully; and, to his surprise, he saw the army that

was marching upwards open to the right and left to make room for those that were descending. Thus, without confusion or intermixture, each held on its way,—the army that was going up marching in two columns to the top, and the other proceeding in one column to the bottom, as if each had been under the direction of wise leaders." Perhaps, in this case, the weight of the descending phalanx forced a passage; but, whether or not, there are, I apprehend, many unthought-of circumstances in the animalcular world which will amply repay the industry and patience of some future Swammerdam, Reaumur, or Huber.

By opening up a new world to us, the microscope has greatly increased our knowledge of the works of God, not only in discovering to us myriads of living beings, of which we else could have had no knowledge, but in displaying to us the structure of organic bodies which would have remained equally hidden. This mention of the microscope leads me to observe, that not the works of nature only, but the inventions of man, should lead us frequently to meditate on the Great First Cause of all. The Almighty has given man a mind capable of going on in knowledge to an unknown extent; and there is not an example of human discovery and improvement that does not call upon our gratitude to him, as the Author of the invaluable gift of mind which he has bestowed upon us. If he has taught the bee to construct its comb according to the exactest rules of mathematics, he has given man a mind capable of arriving at the developement of those rules.

To consider the works of man as in one sense the works of God, ought to inspire us with a wish to become acquainted with works of art, and with the sciences, on the principles of which they are constructed. If I study the formation of a ship, that admirable piece of mechanism, will it not give a higher importance to my researches to trace its origin through the human mind up to the Deity? Mankind, indeed, have discovered the art of ship-building; and, like all other arts and pursuits in which mind is concerned, it has gone on, step by step, to its present state of improvement. Instinct is perfect from the first, but the knowledge obtained by the human mind is progressive; for it was intended that man should acquire his knowledge by the exercise of his thinking powers, and that the knowledge of one generation should go down to another. But still the original gift, the enjoyment of reason, is from the Almighty; and, in this point of view, he is as much the fabricator of the ship as he is of the honeycomb.

Whether these remarks be logically correct or not, they may point out one useful mode of viewing things, and of reflecting on them; that is, of referring to the Deity even through works of human invention; and such a mode of considering these must tend, I should think, to increase brotherly love among mankind, — a thing so much spoken of, and so little known. When we see a mechanic working at his trade, and observe the dexterity which he displays, together with the ingenious adaptation of his tools to their several uses, and then consider the original source of all this, do we

not see a being at work, employing for his own purposes an intelligence derived from the Almighty? and will not such a consideration serve to raise him in our opinion, rather than induce us to look down slightingly upon him for being employed in a mechanical trade? For my own part, when I watch a mechanic at his work, I find it a very agreeable, and, I believe, a very useful, kind of mental employment, to think of him as I would of an insect building its habitation; and, in both, see the workings of the Deity.

This way of considering the productions of human ingenuity would tend to do away the idle declamation which some use for the purpose of disparaging the arts, and of representing the works of man as trifling. A similar error is also fallen into by comparing some of nature's productions with man's, and giving the former an undue and unjust superiority; as, for example, in the following thrice-hackneyed passage: —

> "It wins my admiration,
> To view the structure of that little work,
> A bird's nest. Mark it well within, without.
> No tool had he that wrought, no knife to cut,
> No nail to fix, no bodkin to insert,
> No glue to join: his little beak was all;
> And yet how neatly finished! What nice hand,
> With every implement and means of art,
> And twenty years' apprenticeship to boot,
> Could make me such another? Fondly then
> We boast of excellence, whose noblest skill
> Instinctive genius foils." HURDIS.

Now this is absolute nonsense. Were a premium

offered by government for the invention of a machine for constructing nests like those of birds, you would, in less than twelve months, have a steam-engine that would throw them off by hundreds in the hour, as perfect as any nest a bird ever built.

Here let me remark, that the exercise of man's thinking powers, his researches in science, his habits of observation, his recording appearances and events, and his success in communicating the knowledge he acquires, united with the spirit of commerce and love of discovery, are the things which have raised him to the exalted state of improvement he now enjoys. Every thing has sprung from mental operation; for, though some important inventions and discoveries have originated in accident, mind has taken advantage of that, and brought them to perfection. And surely this gives us higher, or, at least, should give us higher ideas of the rational, the intellectual part of our nature, than if we had arrived at our present attainments by any thing but our own exertions. What is there, in fact, useful or ennobling, or satisfactory, in our knowledge, and in the improvement of our race, that has not been attained by human effort and perseverance? Have any of the great discoveries that have raised man to his present eminence come by miracle or supernatural aid? Whence came the art of printing? — whence the thousand inventions, and the useful and scientific knowledge, which characterise civilised society? — whence the manufacture of glass, of paper, of damask (I put these things down as they occur, for there is no need of selection)? What is the origin of steam navigation? — what

was the origin of navigation at all? Whence did the cotton mill originate, or any other mill? Whence our knowledge of the sublime phenomena of the heavens, of the lightning and the thunder? Who taught us to calculate eclipses, to measure the earth, to tell the size and distance of the sun, to discover the moons of Jupiter and the ring of Saturn? Whence came our knowledge of the diving-bell, of the composition of the atmosphere, of that of water? Who discovered to us that the diamond is but charcoal? — and whence all the knowledge implied by the term philosophy? All this is the genuine offspring of the mind of man brought into proper exertion, experimenting, observing, and thinking for itself, undismayed by tyranny, and in defiance of superstition, that deadly enemy to all true knowledge and all true improvement of the human race.

LETTER X.

Before taking some other excursion, let us look to a very few things at home. Have you ever attended to the history and structure of the common house-fly? If so, you have done what not one in a thousand has. It is a teasing, impudent, troublesome animal; it dirties our furniture, ceilings, pictures, books, and every thing on which it is allowed a footing; and yet we have comparatively little cause to complain. In some countries it is so numerous as to prove an absolute torment. In the southern provinces of Spain, especially, flies abound to a distressing degree. In the city of Murcia they are in such swarms, that in numbers of houses it is the practice of a servant to wave branches of trees over the table during the times of eating; sometimes a large fan is kept constantly in motion; and "the great have a servant at their elbow, whose sole employment is, with a napkin, to keep off the flies."* Mr. Young observes, that "they are the first of torments in Spain, Italy, and the olive districts of France: it is not that they bite, sting, or hurt, but they buzz, tease, and worry: your mouth, ears, and nose are full of them; they swarm on every eatable; fruit, sugar, milk, every thing is attacked by them in such myriads, that if they are not driven away incessantly by a person who has

* Townshend's Travels in Spain, vol. ii. p. 257.

nothing else to do, to eat a morsel is impossible." He farther states, that if he farmed in those countries, he thinks "he should manure four or five "acres every year with dead flies."* Even in London, in the year 1707, they were so numerous, that people, trampling on them in passing through the streets, left the impressions of their feet, as if they had been walking in snow.†

The fly, then, has not been created to add much to the comfort of the human race; but we should consider the swallow as our benefactor, for, I believe, it is in a great degree through the swallow tribe that the excessive multiplication of the fly is kept down. Is it probable, that the destruction of these birds in Spain, and elsewhere, causes such myriads of the insect to exist, as is stated above? This I cannot answer; but, from what I have myself observed, I think there are grounds to suspect that it is. In Andalusia, I have repeatedly seen Spaniards shooting every little bird they could find for the market, and carrying them strung in form of festoons over their shoulders. I have also seen them take many small birds by limed twigs, which, when caught, they killed by a squeeze in the hand. Too often, indeed, the squeeze did not produce instant death; and it was a pitiful sight to see the beautiful little creatures gasping and panting on the ground, the blood oozing from their bills. Are men never to learn any feelings of humanity? Never, I believe, in a country like Spain, where females delight

* Travels in France in 1787—1789, vol. ii. p. 25.

† Northoucke's History of London, p. 292.

in bull-fights, and human beings are burned by the church for not professing to understand what cannot be understood; nor in England, where horses are systematically put to death by hard work and flogging, and where the enaction of laws to punish acts of cruelty is so generally thought to be "beneath the dignity of the legislature." As for Ireland, humanity is there a still emptier sound, and not a voice is raised against that hardened indifference, with which people of all ranks, with very few exceptions, look upon the sufferings of animals groaning under our tyranny and injustice: but on this subject, I fear, I am but wasting paper.

If swallows are eaten in Spain, and pursued to destruction with the same avidity as other small birds, we may readily conceive that this causes the excessive accumulation of flies. Buffon mentions, that in France, the domestic swallow roosts, at the close of summer, in great quantities, on alders by the banks of rivers, "and numbers are caught, which are eaten in some countries." Valencia in Spain, and Lignitz in Silesia, are specified as being among those places.* I find, in the same author, that the martin is caught at Alsace in nets: he states, that Professor Hermann assures him, "that the white-rumps, or martins, grow fat in autumn, and are then *very good to eat.*" Of the sand-martin, another of the swallow tribe, the same author states, that "the young ones grow very fat, and may be compared for delicacy to the ortolans;" and also, that "in some countries, as in Valencia in Spain,

* Wood's Buffon, vol. xvii. p. 476.

there is a *great consumption* of sand-martins." * He says also of the swift, that "this bird, like all the rest of its kind" (that is, all the swallow tribe), "is excellent for the table when fat; the young ones, especially those taken out of the nest, are reckoned, in Savoy and Piedmont, *delicate morsels.*" A young bird taken out of the nest a delicate morsel! I hope the heartless epicures may be eaten up by flies, till they become of a different opinion.

The common fly is said to breed in dunghills; but, from its ubiquity and numbers, I suspect that it must breed in a great variety of places: the truth, however, is, that I am very ignorant of the economy of this insect. When magnified, it is a very wonderful object; its compound eyes, especially, are extremely beautiful: but I will now dismiss this common animal, by adverting slightly to the extraordinary strength possessed by the muscles which move the wings of insects. There is nothing more frequently under our inspection than the motion of the house-fly; and I suppose you have often been amused in watching its airy gambols, when a number have got together, and are frisking about as if they were dancing a quadrille, or rather going through the rapid mazes of a Highland reel.

But, with whatever ease they make these evolutions, it is a process neither simple nor unworthy your consideration. The wings of many insects are of such an extreme tenuity, that "fifty thousand of them placed over each other, would not form a pile

* Wood's Buffon, vol. xvii. p. 508.

a quarter of an inch in height;" * and yet each of these, thin as it is, is double; so that the actual number of laminæ here would be one hundred thousand. That such a film could oppose the slightest resistance to the air might seem problematical; but it is strengthened by the distribution of strong elastic nervures, or ribs, through it, and is thereby rendered perfectly fit for its office. But the most wonderful circumstance connected with the insect's wing, is the extraordinary rapidity of its motion. Mr. Kirby, in the second volume of the "Introduction to Entomology," observes, that "an anonymous writer in Nicholson's Journal calculates that, in its *ordinary* flight, the common house-fly makes with its wings about six hundred strokes, which carry it five feet, every second; but if alarmed," he states, "their velocity can be increased six or seven-fold, or to thirty or thirty-five feet, in the same period. In this space of time a race-horse would clear only ninety feet, which is at the rate of more than a mile in a minute. Our little fly, in her swiftest flight, will, in the same space of time, go more than the third of a mile. Now, compare the infinite difference of the size of the two animals (ten millions of the fly would hardly counterpoise one racer), and how wonderful will the velocity of this minute creature appear! Did the fly equal the race-horse in size, and retain its present powers in the ratio of its magnitude, it would traverse the globe with the rapidity of lightning."

* Lardner's Cabinet Cyclopædia, vol. v. p. 11.

The history of the flesh-fly (*musca carnaria* of Linnæus) is better known than that of the common one. It deposits its eggs on flesh, and then the latter is said to be fly-blown. It is a law of nature, that the particles which form an organised body shall, on its dissolution, serve for the sustentation of others; and hence, when an animal dies, it is taken possession of, in one way or another, by those which are living. In hot weather a dead body runs rapidly into putrefaction, and in that state attracts, by its odour, those flies which lay their eggs in flesh, and the carcase is very soon occupied by myriads of maggots, which are hatched from those eggs, and are flies in the larva state. When we think of the horrible odour which a putrefying animal emits, we cannot but admire the wise arrangement by which this very odour is made agreeable to multitudes of living creatures; for, as Paley remarks, maggots revel in putrefaction. We observe, also, that it is most powerful at those times when flies are most numerous and active; that is, in hot weather. In the egg itself, there is the very wise provision that it is hatched in a few hours; and the maggot arrives at its full growth in a week; and thus you see how divine wisdom is displayed in every thing — even in what, to ordinary apprehension, is most disagreeable or disgusting. If the fly's egg did not hatch in a very short time, and the larva soon attain its full growth, the object in view would not be gained. The larva of a beetle may be so constituted as to live for years under ground, because the roots of grass and other plants on which it feeds do not fail; but if the larva

of the flesh-fly did not become perfect in a very short time, it must perish, because the source of its nourishment in that state soon dissolves and disappears. We find, too, that in some other species of flies, whose larvæ feed on flesh, not a single moment is lost; for, instead of an egg being laid, the larva is deposited in the *living state*, the egg having been previously hatched within the body of the parent; this, indeed, is stated to occur very often with the common flesh or blow-fly.

I am inclined to believe that maggots have the property of keeping the part in which they are situated moist, when, but for their presence, it would be dried up by the sun and air. In making dried anatomical preparations, I have several times remarked, that any part where a maggot was placed was wet and soft, though the rest was dry; some experiments, however, would be necessary, fairly to decide this point.

There is a curious passage in Linnæus's "Tour in Lapland," which would lead one to suppose, that some birds supply a fund of nutriment to their young, by placing dead bodies near the nest for the purpose of breeding maggots. He mentions having found the nest of what he supposed to be the eagle-owl, on the side of a high mountain; it contained three young birds, one of which was much larger than the others: he says, "I believe the two smaller birds were the offspring of the eagle-owl; close to the nest lay a few small bones, of what animal I am ignorant. These birds were all quite full fed. Near them was a large dead rat, of which the under-side was already putrefied, and full of maggots. I

verily believe that these young birds cannot digest flesh, but are obliged to wait till it decays, and affords them maggots and vermin." *

The common or house-spider is an animal whose history is much more remarkable than that of the fly; but I must refer you for an excellent account of it, and spiders in general, to that admirable production, "Insect Architecture," which forms the third volume of the "Library of Entertaining Knowledge." I shall only remark, that very few people know the fact, that each thread which a spider spins is composed of above four thousand other threads; that four millions of the threadlets of a young spider would not be thicker than a hair of a man's beard; that one species lives in water, in a house of air like a diving-bell; that some exotic species build houses in the ground, and close the entrance with a door, having an elastic hinge which spontaneously keeps it shut: but these, and many other interesting particulars, you will find in the work alluded to.

I know not whether you are aware that the noises made by insects are not formed by the mouth, but are produced by the motion of the wings, or by the friction of certain parts on each other. The latter mode is that by which the chirrup of the cricket and grasshopper is caused, the noise being produced by the animal rubbing the wing-case of one side under and against that of the other. The cricket, though often a troublesome inmate in houses, adds, on some occasions, considerably to the combination

* Lachesis Lapponica, vol. i. p. 41.

of pleasing circumstances which attend the close of a summer day. The sounds especially which characterise the evening twilights of our own islands are, in general, of a very pleasing description. Excuse me for reminding you of the following beautiful lines in Goldsmith's "Deserted Village:" —

> "Sweet was the sound, when oft at evening's close,
> Up yonder hill the village murmur rose;
> There, as I pass'd with careless steps and slow,
> The mingling notes came soften'd from below;
> The swain responsive as the milk-maid sung,
> The sober herd that low'd to meet their young;
> The noisy geese that gabbled o'er the pool,
> The playful children just let loose from school;
> The watch-dog's voice, that bay'd the whispering wind,
> And the loud laugh that spoke the vacant mind:
> These all in sweet confusion sought the shade,
> And fill'd each pause the nightingale had made."

Add to these the hum of the evening insects, sporting in myriads through the air: —

> "When pensive twilight in her dusky car,
> Slowly ascends to meet the evening star;
> Above, below, aërial murmurs swell,
> From hanging wood, brown heath, and bushy dell."
>
> *Rogers.*

In many parts of the world the state of things is very different from this: the roar of the lion may be heard, not less terrific than thunder; while the howlings of the jackall, the hyæna, and other ferocious beasts, add horror to the night. In some

countries innumerable frogs keep up a constant croaking from sunset to sunrise; and frequently swarms of mosquitoes (at Surinam not unaptly called "devil's trumpeters") not only stun the ear of night with their shrill pipings, but bite and torment the traveller wherever they can find a spot uncovered. Birds of the goatsucker tribe, too, often perform a very important part in the nightly concert. I shall not often trouble you with long quotations; but the following account of the goatsuckers of Demerara, taken from Mr. Waterton's very amusing "Wanderings" in that country, is so interesting, that, notwithstanding its length, I am induced to give it you:—

"There are nine species here; the largest appears nearly the size of the English wood-owl. Its cry is so remarkable, that, having once heard it, you will never forget it. When night reigns over these immeasurable wilds, whilst lying in your hammock, you will hear this goatsucker lamenting like one in deep distress. A stranger would never conceive it to be the cry of a bird; he would say it was the departing voice of a midnight-murdered victim, or the last wailing of Niobe for her poor children, before she was turned into stone. Suppose yourself in hopeless sorrow, begin with a high-toned note, and pronounce ha, ha, ha, ha, ha, ha, ha, each note lower and lower, till the last is scarcely heard, pausing a moment or two betwixt every note, and you will have some idea of the moaning of the largest goatsucker in Demerara.

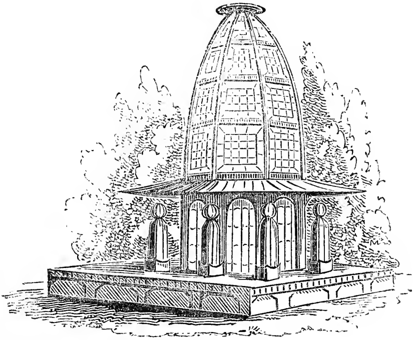
"Four other species of the goatsucker articulate

some words so distinctly, that they have received their names from the sentences they utter, and absolutely bewilder the stranger on his arrival in these parts. The most common one sits down close by your door, and flies, and alights three or four yards before you, as you walk along the road, crying, who-are-you, who, who, who-are-you. Another bids you work-away, work, work, work-away. A third cries mournfully, willy-come-go, willy, willy, willy-come-go. And high up in the country, a fourth tells you to whip-poor-will, whip, whip, whip-poor-will.

"You will never persuade the negro to destroy these birds, or get the Indian to let fly his arrow at them. They are birds of omen and reverential dread. Jumbo, the demon of Africa, has them under his command; and they equally obey the Yabahou, or Demerara Indian devil. They are the receptacles for departed souls, who come back again to earth, unable to rest for crimes done in their days of nature; or they are expressly sent by Jumbo or Yabahou to haunt cruel and hard-hearted masters, and retaliate injuries received from them. If the largest goatsucker chance to cry near the white man's door, sorrow and grief will soon be inside; and they expect to see the master waste away with a consuming sickness. If he be heard close to the negro's or Indian's hut, from that night misfortune sits brooding over it, and they await the event in terrible suspense."

Thus you see that in all countries ignorance and superstition are linked together. The poor negro,

or the Indian, may be forgiven ; but how many are there among ourselves who are equally ignorant of nature, and equally ready to run into absurdities, derogatory to God, considering the works of his hands as of evil omen, and attaching to them powers which belong to him alone!



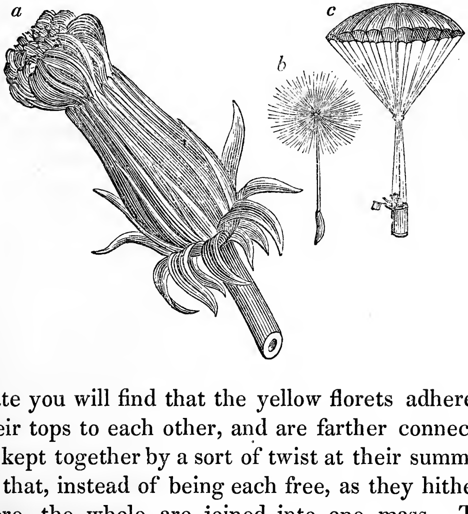
LETTER XI.

Let us now take a walk to the sea-shore, and on our way to it consider, first, a few of the common objects which may present themselves. There is one plant which we cannot fail to recognise, namely, the dandelion, which is found every where; and I may remark that when a plant is very common, it probably has extensive and important uses in the economy of nature. Dandelion has long been employed on the Continent as a remedy in obstructed liver, in pulmonary affections, and in cutaneous and various other diseases. In England it is pretty extensively used in incipient scirrhus of the liver, chronic derangement of the stomach, and several other complaints. In France its young leaves are eaten as a salad, and at Göttingen the poorer classes are said to roast the roots and use them as coffee. But I believe that the great object which the dandelion serves in the economy of nature, is to afford a copious supply of nutriment to innumerable insects. It is almost the only early flower spread every where to feed the bee, and, of late, I have been particularly struck with the fondness of the wild bees for it in spring; but it is visited by many other insects, especially various species of small beetles, which lurk among its florets.

This common plant affords a beautiful illustration of the dissemination of seeds by the in-

tervention of winged appendages. The flower is compound, and each floret or smaller flower of the group produces one seed. When the whole flower has been fully blown for some days (the time, of course, will vary according to the weather), the calyx, or flower-cup, contracts, and the appearance which the entire exhibits is as at *fig.* 9. *a.* In this

Fig. 9.



state you will find that the yellow florets adhere at their tops to each other, and are farther connected or kept together by a sort of twist at their summits; so that, instead of being each free, as they hitherto were, the whole are joined into one mass. This union of the withered florets is not without a design. It enables the whole of these now useless parts to be cast off at once, without in any way interfering with the evolution of the seeds; and it likewise makes them serve as a protection from the rain. The seed-down, in this species, stands upon a little

pillar, and is radiated like a star (*fig.* 9. *b*). This pillar seems to me to answer two purposes: it grows to its full length *after* the florets have withered; and as the base of each floret rests on the top of a pillar, by the time that the florets are completely prepared for falling off, the pillars have grown up so high as to push them fairly from their place, and they fall in a single parcel at once, leaving the seeds unembarrassed by their presence, and perfectly clean and free from encumbrance. After the fall of the florets, the leaves of the calyx keep contracted till the pillars of the seed-down have grown nearly as long as themselves, and then they slowly open, and the stars of down expand in proportion. The attachment of the seeds to the receptacle is still pretty strong, and such as to resist the action of the wind; the calyx leaves continue to be more and more deflected, or turned back, till at length they are on a line parallel with the stalk, and that beautiful white globe is formed, which is so well known to every child by the name of "clock." The seeds are now ripe, and so loosely attached, as to be separated and carried off by the breeze.

This object is so common, and we have been all our life so much used to it, that ninety-nine people at least out of every hundred would laugh at seeing you or any one else seriously employed in its examination. But you must learn not to mind the remarks or sneers of ignorance or prejudice: let nothing lessen your love of studying God in his works; and when people laugh at *you*, you must just learn to pity *them*. Of what incal-

culable value, I may ask, would it not be to thousands to have such a resource as this pursuit which I have undertaken to recommend to you! How many men of independence and leisure are there to whom life is a burden; on whom time hangs like a weight of lead; and who are eager to plunge into any amusement that may make them forget themselves, and kill the passing time that is fleeting so rapidly to a close! How many persons have committed suicide from want of mental occupation; how many have gone mad by dreaming away their hours in reveries and foolish conceits! But what are these men, to whom time is a burden? Are they geologists, or astronomers, or chemists? Are they botanists, or landscape painters? Are they butterfly-hunters, to use a term often spoken in derision? Are they naturalists, or philosophers of any kind? We may safely, I believe, answer in the negative. No one who pursues science is likely to complain of the *tedium vitæ*, the *ennui* of modern times: and I feel farther convinced, that science in union with natural religion is the pursuit best of all calculated to make our time pass happily, and the world we inhabit seem a paradise. It affords a rational and solid reason for cultivating these studies, that God is the ultimate object of our research. This is the true *cui bono*, the vast and glorious good of scientific pursuits. If an object, however apparently trifling, a moss, a sea-weed, an insect, or a shell, lead me into trains of reflection on the Almighty Power which formed the universe; if this reflection give happiness to myself, and nearer views of the Deity, while it cannot

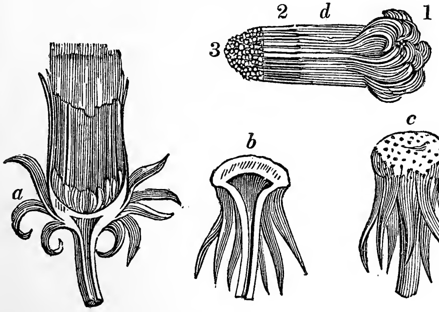
possibly engender any corrupt, or vicious, or other bad passion, either to disturb my own peace, or injure my neighbour, am I to be ridiculed? I may be so; but then it is through the ignorance of him who ridicules, and if he knew better, he would praise rather than blame.

A second use which the pillar of the seed-down of dandelion appears to serve, is this: you know how generally the plant is distributed; it is found in almost all situations, even at the sides of roads, and in other places where very few plants, but itself, can exist. Now examine the mode in which the seed descends to the ground, when it has been blown into the air. *Fig.* 9., *c*, represents an aëronaut descending, by means of a parachute, and (*b*) is the seed of the dandelion. They both descend on the same principle; but easy descent is the great object of the aëronaut, while the seed-down of the dandelion is for the double purpose of a wing and a parachute. Under the influence of the wind, like a wing, it carries the seed off, but when the latter arrives at a place which is calm, the star of down acts exactly like a parachute, and the seed comes to the earth perpendicularly, so as to touch it first with its lower end. This you can, at any time, examine for yourself; but I would have you to enquire what the object in view is. Why is it that a provision is made for the seed falling to the earth, end foremost? Perhaps it gives a better chance of dropping into cracks, or fissures, which, as the plant has large roots, may be particularly advantageous to it. When we magnify a seed, we observe that its upper end has a number of spinous

projections, especially on its sides, which point obliquely upwards and outwards. Is it probable that these are for preventing the seed-down from dragging the seed out of any fissure, in which it may have settled? This may not be improbable; and I find that the slightest force, applied laterally, will break the pillar off from the seed, but that a greater force is necessary to separate it in the longitudinal direction.

The way in which the globular form is given to the head of seeds, I have not seen explained. It is not done simply by a bending back of the leaflets of the calyx, but by a change of form in the receptacle, or part on which the seeds stand. Examine a vertical section of a dandelion flower at any period before the expansion of the seed-ball, and you will perceive that the part on which the florets, or the seeds, are placed is concave (*fig.* 10. *a*).

Fig. 10.



But the section of the same part, when the seeds are expanded, is as in *b*; for when the seeds are

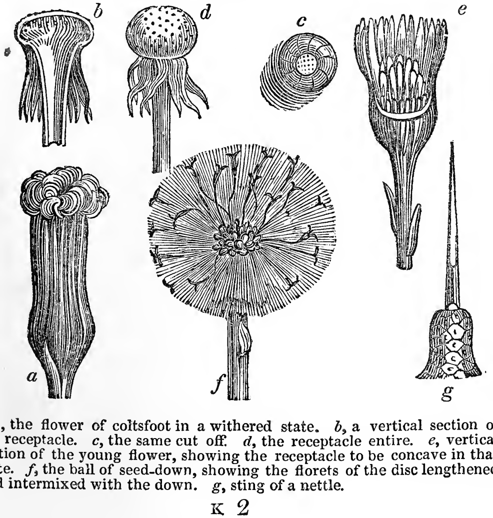
ripe, the receptacle becomes convex, and its margin turns back, so as to give a button-like form to the whole, as at *c*. The form of the seed-ball, therefore, is effected, not by a sensibility in the calyx, but by the convexity assumed by the receptacle.

The calyx, however, does possess a very considerable degree of sensibility, and the dandelion affords a good example of the periodical opening and shutting of flowers. On looking at the button-like receptacle, after the seeds are blown off, we perceive a shallow pit or dimple in its middle; and I think that this is connected with a very beautiful part of the economy of the plant. I have stated, that when the florets have become withered they adhere together, and at last fall off in one bundle when the down-pillar is near its full growth. Now, the growth of the outer series of pillars is more rapid than that of the central ones; and the consequence is, that the withered florets are sooner ready to be disengaged from them: the tubes, too, of the florets dry up sooner than in the centre, so that when the process is nearly completed, the bundle adheres chiefly to the central pillars; these, however, continuing still to lengthen, the bundle is at last pushed from its place, and falls off. This accounts for the conical form which the under end of the bundle exhibits, and which we may see, at any time, by picking it off when nearly ready to fall. *Fig*. 10. *d* represents this: 1 shows the florets twisted and adhering to each other; 2 their tubes or lower parts which rested on the pillars; and, 3 those which stood on the pillars of the dimple.

The seeds of dandelion are extremely light, and the rays of the parachute or star of down are very numerous, and, when magnified, each is seen to be waved, and also armed with many teeth, or minute spines, directed obliquely towards the point: they are generally alternate, but very often in pairs.

I have remarked that in coltsfoot and groundsel, the seed-ball is formed exactly in a similar way to that of the dandelion; but in neither is it so clean, because in them there is no provision of a pillar for raising each floret from its seed, and, therefore, we generally find numbers of them intermixed with the seed-down. The *twisting* of the florets in coltsfoot, however, is still more remarkable than in dandelion (*fig.* 11. *a*). In all these

Fig. 11.



a, the flower of coltsfoot in a withered state. *b*, a vertical section of the receptacle. *c*, the same cut off. *d*, the receptacle entire. *e*, vertical section of the young flower, showing the receptacle to be concave in that state. *f*, the ball of seed-down, showing the florets of the disc lengthened and intermixed with the down. *g*, sting of a nettle.

plants the stalk is hollow, and in the coltsfoot especially, the developement of the receptacle seems more like an inflation by air than an increase of substance (*fig.* 11. *b*). This, indeed, is so remarkable, that when it is cut off the top of the stalk, by a transverse section, it resembles a hollow case, the sides of which are so thin as to let the light shine through it (*fig.* 11. *c*). Though there is no pillar for the seed-down in coltsfoot, there is a curious provision, which seems to me intended to serve the same purpose. The little tubular or bell-shaped florets which occupy the centre of the flower are very short, but the tube of each continues to grow; so that, at length, when the down-ball is formed, the central florets project as far from the receptacle as those of the ray or margin.

The seed in these plants being formed, is left entirely to the wind for its dissemination; and when the down-ball is kept in a house, or free from the wind, not one falls; the stalk withers and hangs down, but the seeds continue to adhere to the receptacle.

Another plant, scarcely less common than the dandelion, is the nettle, three species of which are natives of Great Britain; the Roman nettle, the common nettle, and the small. The first is limited to certain situations, but the other two are found almost every where. The common or large nettle is known by grievous experience to every one, though perhaps you have never yet enquired whence the pain arises from touching it. You have often been pricked with a pin or needle, but you will recollect that the pain succeeding that

injury is very different from what follows the stinging of a nettle. Now, the wound made by either of these is perhaps twenty times larger than that made by the sting; so that in the operation of the latter there must be something more than the mere extent of the wound to account for the greater pain which is produced. In fact, it is a process altogether analogous to the stinging of a bee, or the bite of a venomous serpent. The sting is not, like a pin or needle, solid throughout; but is hollow in the centre, and perforated at the point; and, when touched, it is not only sharp enough to pierce the skin, but also is so constructed as to inject a particle of poisonous fluid into the wound it makes, and that is the source of the pain which follows. The wound itself is so minute that it would scarcely be felt, but the poison irritates, inflames, and causes the well known pain alluded to.

The poison-fang of the serpent is, in some respects, different from the sting of the nettle. There is a gland on the cheek, which secretes or forms the poison; and this is conveyed by a duct, and discharged into a bag, which serves as a reservoir. With this reservoir the base of the fang is connected in such a way, that, when the point of the fang presses against an object, the resistance pushes its root into the poisonous fluid, and this of course passes into the cavity of the fang, and is ejected from its aperture, which is a slit at some distance behind the point. Were it not for this poison, the bite of a serpent would only cause a simple punctured wound; but, by the contrivance mentioned, it produces death in a very

little time, even in the largest animal which the serpent will attack. Let us not pass over this subject without a little reflection. It offers us a striking example how the Almighty can turn the simplest circumstance into the most important. Only a small number of the serpent tribe are armed with the poison-apparatus; the rest have simple teeth, and take their prey by suddenly twisting round its throat and strangling it. The poisonous serpent, on the other hand, merely gives its bite, and then watches the animal bitten till it falls dead.

The formation of the poison, though we cannot understand the process, is a very extraordinary instance of the mysterious and unfathomable knowledge and power which pervade all the works of God. When we consider our own frame, we find that the blood, while it nourishes and supports life in every part, is also the material from which fluids are formed as unlike itself and each other as is possible. These new fluids are produced from it, in general, by the action of glands; but, although we are acquainted with this fact, we know nothing whatever of the *mode* by which the glands effect the change. We know that the lachrymal gland forms or secretes the tears from the blood which circulates through it, and that the salivary glands form the saliva also from the blood; but *how* either the one forms tears, or the others saliva, we cannot tell. We may dissect the organs which effect the change, but we cannot penetrate into the hidden power which God, in his wisdom, has imparted to them, of forming fluids so essential to our well-being. There have, indeed, been theories enough

to account for secretion, but they are to no purpose, and are now abandoned.

Milk is another fluid formed from the blood by the breast or mammary gland. The office of the lachrymal and salivary glands is necessary to us through life, and from the moment we breathe; and, therefore, God has ordained them to be developed, and to operate, from birth till death. But the secretion of milk could be of no use except during a certain period. Now observe this wise and wonderful ordination, which all are acquainted with, and scarcely any have reflected on. The mammary gland itself is not developed until the age of womanhood, prior to which it would have been useless. The gland is, also, so constituted as not to assume its office until the time arrives when it is required; that is, when the woman has become a mother. The organ which for so many years had remained undeveloped, or, being developed, had remained inactive, now, in a short period after childbirth, assumes its intended office, and from the blood that circulates through its vessels elaborates the milk, and thus becomes a fountain of nutriment and life to the child. But there is more. God never leaves his work incomplete; and, in so far as we have gone, it would be so were there nothing farther. The nutriment is provided; how is the child to take it? It has an irresistible propensity to suck. Where did it get that propensity? Neither you nor I can tell: all we can say is, that the wisdom and unerring ways of God are manifest in it; but God only can know how the propensity is given; it completes the

process so far, and proves itself to be the arrangement of one who is equally wise and omnipotent. Let me mention farther, that the child cannot stand; the muscles of its limbs are too weak; but the muscles which do the work of deglutition are as perfectly fitted for swallowing a fluid as at any future period of life; so that, while there is the ungovernable propensity to suck, there is also the full capability to swallow.

The liver, again, is a very complicated gland, of whose *essential* use, I believe, we are as yet ignorant; though it performs one very obvious function, the secretion of the gall or bile. This fluid is yellow or greenish brown, acrid, and nauseous to the taste, and as unlike milk as any two things can be to each other: yet it also is formed from the blood. There are various other secretions, all differing most materially from each other, with which I need not now occupy your time; but, from the observations I have made, you may readily conceive, that as two fluids so opposite in quality and appearance as milk and gall can be formed from the common circulating mass, the Almighty, to answer his own good purposes, could, by similar means, ordain a fluid to be formed from it of any assignable qualities; and hence we have the dreadful venom of the serpent elaborated from its blood by a small gland placed upon the cheek, and to an analogous process we are to refer the poison which produces the stinging pain of the nettle. That plant, the small species of which (urtica *urens*) stings the most severely, is covered all over with hairs; but by using a microscope, or a

magnifying glass, you may perceive that these are not all of one kind, some being perforated, which are the stings, while others are not. Each sting stands upon a pedestal, and this pedestal performs the office both of gland and poison-bag. It is cellular and spongy within; the sting is placed on its top, and may be moved by a slight pressure to either side, or round in a circle; it seems to stand, as it were, on a universal joint. When a body touches its point, the base is pressed down into the spongy pedestal, and the poisonous fluid rushes up through the tube of the sting, and flows out of the terminal aperture. (*Fig.* 11. *g.*)

It is a curious part of the history of both venomous animals and plants, that some species or other of living beings feed on them with the utmost impunity. The quadruped called the ichneumon devours the most venomous serpents; and the hog is stated to hunt the rattlesnake, and eat it, without ever experiencing any ill effect. You know, I suppose, that the poison of the serpent is only injurious or fatal when deposited in a wound, or applied to a part where the skin is broken; but it may be swallowed with perfect safety. Such, at all events, is true with respect to the viper; and, I believe, it is understood to extend to all other species. No danger, therefore, can result to the ichneumon or hog, no matter how much of the poison they may swallow; but we can scarcely conceive that they can, at all times, escape without being bitten; and there may, perhaps, be something in their constitution for the express purpose of saving them from the fatal effects it produces in other animals.

With regard to internal poisons, we know, that, besides the goat, which is fond of hemlock, many animals will thrive on what is poisonous to others; and the same remark would, perhaps, apply with equal truth to poisons which act directly through the circulation, were we sufficiently informed on the subject. However this may be, we know that the caterpillars of several butterflies live on the *nettle;* but how they avoid the usual effects of the stings I cannot tell. There is a remark respecting one of these, in the "Journal of a Naturalist," which strikes me as curious, and deserving of full investigation; it is this:—"It is rather singular that the larva of the admirable butterfly, which feeds upon the large hedge-nettle, has the spines which arise from its body branched, and each collateral hair arises from a little bulb, similar to that of the plant on which it is chiefly found." * Can it be possible that the caterpillar has, in its turn, stings which wound those of the nettle, and destroy their function? This is worth enquiry; and, all events, it has been long known, that there are caterpillars, as that of the gipsy-moth, and others, which produce an itching, and some which cause a stinging pain when held in the hand. It is even asserted, that, at Surinam, there are two species of hairy caterpillars, which, if they touch a person's skin, cause a blister, that is followed in a few hours by shivering and acute fever, and that, in bad habits of body, the blister sometimes runs into a state of mortification. Observation must prove whether the

* Ed. 2d. p. 151. note.

conjecture I have thrown out be founded on truth or not.

If the vessels of an animal body are capable of secreting a great variety of different substances, those of vegetables are not less so; indeed, the gums, resins, extractive substances, oils, balsams, turpentines, sugars, acids, and other products of vegetation, are endless. Some plants form the most deadly poisons, others the most valuable drugs, dye-stuffs, and astringents; and, in the great diversity which their structure presents, we find many analogous processes to those carried on in the animal frame. Thus, the blood of the nettle serves, through the medium of the glandular sponge on which the sting is placed, to form the venom, just as the poison-gland of the serpent serves to form the deadly secretion of that animal.

The nettle, in an economical point of view, is not destitute of some value: its young leaves are used in many parts of Scotland and Ireland in broth, and are also eaten as greens. Lightfoot states, that in Arran, and other Scottish isles, a decoction of nettles is used for renneting milk. The stalks have been manufactured both into cloth and paper. The roots are used to dye yarn yellow, and the juice to dye woollen cloths green.

What I have stated respecting the nettle is one proof, among many, that the interest an organised body may possess is not always in proportion to its beauty; on the contrary, indeed, I believe that beauty may have been bestowed on many objects, as a compensation either for their want of something striking in their history, or because, from

their natural place of abode and habits, the beauty of the workmanship is the only thing of which we can avail ourselves. Why, for example, are flowers in general so exquisitely beautiful as we find them, if it be not to exhibit to us the hand of God, and to afford us, even in the colouring of a blossom, a manifestation of himself, and a rational cause for turning our thoughts towards him? Look with a magnifier at the flower of *London pride*, or of *forget me not*, and enquire of yourself why these minute objects are so lovely, why scarcely any of the larger flowers excel, and not many equal them: extend your observation to some of the minute insects, and reflect why they are dressed in colours as brilliant as those of the peacock: magnify a gnat, and consider the superb feathered antennæ which grace its head; examine its whole structure, see the wonderful mechanism which is in every part; the minute perfection, the elaborate finishing of this little being; remember that, in addition to the external structure, there are its appetites and functions, its stomach and bowels, its organs of breathing, its muscles of motion, its several senses, and perhaps its passions. Think on these, but not with the transitory admiration which we often observe in persons who for a first or second time see objects in a microscope. Be not content with the cold acknowledgment that it is one of the wonderful works of nature, and then let it slip from your memory. I tell you it is the work of God; and I believe that the too liberal use of the term *nature* has given rise to much of the apathy with which the objects of the creation are regarded. It is very

true, indeed, that when we say nature produces a plant, or an animal, the true meaning is, that God does so; nature here being used as a synonymous term; but still the word has so many applications, and is employed in such a variety of ways, that we insensibly get into the habit of using it, in natural history and other sciences, as if it were some inferior power, or agent, acting by itself; and we talk of the works of nature, without any impression being on our minds at the time, that they are in truth the works of the Deity himself.

To prove that we often find the greatest beauty where we might least expect it, let us examine a fine collection of shells. The animals which form and inhabit them, generally reside in situations where it is almost impossible for us to learn any thing of their history; but see what compensation we have for that. The skin of a quadruped, or a bird, will soon perish, unless the greatest pains have been taken to preserve it by some antiseptic wash or powder; and if it be stuffed, every care is required to keep it from damp and insects. But if it be difficult to preserve a quadruped or bird, we have opportunities of recording its history, of observing its habits, and of adding to our knowledge of it, in its living state. In the inhabitant of the shell, *that* is next to impossible; we cannot reside with it at the bottom of the sea, we cannot study its manners, habits, and modes of working, as we can those of a bee. But of all objects, for forming a beautiful and permanent collection, the coverings in which the animals reside are perhaps the best. These coverings, or shells, are infinitely varied;

some are marked with the most rich and beautiful colours, and with the greatest variety of pencilling; their forms are endless. "What," says Pliny, "can be more gratifying than to view nature in all her irregularities, and sporting in her variety of shells! such a difference of colour do they exhibit! such a difference of figure! flat, concave, long, lineated, drawn round in a circle, the orbit cut in two! Some are seen with a rising on the back, some smooth, some wrinkled, toothed, streaked, the point variously intorted, the mouth pointing like a dagger, folded back, bent inward; all these variations, and many more, furnish at once novelty, elegance, and speculation."

There is no trouble in preserving them, there is no fear of their decaying by time, they will be the same in fifty years as they are to-day; and hence, if there be almost insuperable difficulties in getting at a knowledge of the inhabitants, there is the greatest facility of becoming acquainted with the habitations. Many, indeed, object to conchology, because we cannot learn the history of the animals themselves; but though we may regret that circumstance, we should not, therefore, disdain giving our sanction to the science; for, though we cannot become acquainted with the architect, that should be no reason for withholding our admiration of the architecture; and our gratitude should be raised towards the Supreme Builder of all, when we consider that he has so ordered, that innumerable gelatinous animals, having perhaps little beauty themselves, should, at the bottom of the ocean, be invested with such elegant and splendid coverings

as those shells are which our cabinets exhibit. Many shell-fish, I must however observe, inhabit the sands and rocks of the shores, and the history and structure of some of them have been tolerably well ascertained.

In our walk to the coast, in the present month of May, many wild plants are in blossom which are sufficiently interesting, but with which I must not detain you. There is the stitchwort rising in the hedge, and spreading its numerous large snowy corollas like stars, making the bush which it adorns shine with a lustre not its own. On the sides of ditches we find the wild violet, and the exquisitely beautiful speedwell, mixing their blue blossoms in contrast with the white or cream-coloured flowers of the wild strawberry; while the pale primrose, or, as Miss Kent calls it, "the irresistible primrose," reminds us of the days when we gathered it along with the dandelion, and the buttercup, to string into garlands for decking our female playfellows. The meadows are white with the wild rocket or cuckoo-flower, and the oozy bottoms yellow with the marsh-marigold; but we must leave all these, with many more, and proceed to the sea, where we shall meet in my next letter.

LETTER XII.

There are few places where I feel more happily situated than at the sea-shore; I mean the shore of the open sea, where the water is pure as crystal; where there are high precipices, and sandy bays, and insulated rocks, and natural basins and caves; and where the opposite land rises lofty, blue, and sublime in the far horizon. How interesting it is, on a stormy day, to remain under the shelter of some bold cliff, and contemplate the billows as they cast their agitated tops to the sky, while the loud resounding shore is white with foam and dashing spray; to watch the breakers vanishing or appearing, as the onward or retiring wave rushes to the land, or again falls back to be buried in the wide womb of ocean; to listen to the alternate moaning or raging of the wind; to view the thick clouds hurrying on their course along the varied sky; to see some sail labouring afar on the dark waters, and breathe a wish for her safety. But what can our wishes avail? If the captain be skilful, the vessel tight, the seamen active and experienced, though the waves roll mountain high, and the wind blow in heavier and heavier gusts, yet the storm may be weathered, and the port be won. If knowledge, and experience, and coolness be wanting; if ignorance preside at the helm; if stupidity stand sentinel at the prow, another addition may be made to the

numbers who have struggled, and sunk, and died in the deep abyss.

But for our walk as naturalists, this calm bright day is best, and we shall commence with the point, or rather promontory of rocks which projects into the sea towards the north, and which, with a similar point about half a mile to the left, forms the extremities of a deep bay, the shore of which is composed of a pure white sand. The land, forming the amphitheatre of the bay, rises in undulating hills on each side, while, in the centre, a small stream glides down to the sloping shore, and there delivers its scanty stores to the great general reservoir.

When we stand on a rock above deep water, or take a sail on a fine summer day, we generally see some animals of the genus Medusa, swimming in the clear sea. In this part of the world they are called falling stars, or sea-blubbers; their substance is scarcely more consistent than a jelly; but many of them have very long tentacula or arms, which are kept waving in various directions. Their motion is very beautiful, and is performed by an alternate contraction and dilatation of their concave, domelike body, so that they move back foremost. There are many species, which vary greatly in bulk, some growing to the weight of many pounds, and others being scarcely a line in diameter. In the end of summer I have often observed them to be thrown in considerable numbers on the shores of Belfast Lough, of nearly two feet in diameter. Some species are beautifully marked with a cross or star; some reflect the rays of the sun in a very splendid

manner; and many, if not all, are phosphorescent in the dark. The organization of these animals must be inconceivably delicate, and it is wonderful how they can exist at all in so boisterous and uncertain an element. Yet they are very numerous, the sea being often crowded with them as far the eye can see, and to an unknown depth. Perhaps they only come to the surface in calm weather, and at other times remain deep down, where they may be safe from the agitatian of the waves.

These medusæ, or sea-blubbers, are mere jellies, and yet they devour fish, and even crabs. How do they escape being torn in pieces by the struggles of these? Delicate and gelatinous as they are, and helpless as they appear to be, they seem to possess a very formidable property, that of paralysing, if not striking dead, their prey by their touch. The medusa has no instrument by which it can wound, yet some species seem to possess a means of destruction even more powerful than that of the serpent. You know how suddenly death is produced by the prussic acid, simply by dropping a little on the tongue of a cat or rabbit. The secretion which covers the tentacular and other parts of the medusa, probably exerts even a more instantaneous effect on the animals it lives on, which seem to be struck dead the moment they come in contact with it. What the nature of this poison is we cannot tell, but in some species it seems to be of a very acrid description, for it is a thing of not very uncommon experience that persons, in bathing, if they come in contact with one of them, will immediately feel as if scourged with nettles, and this

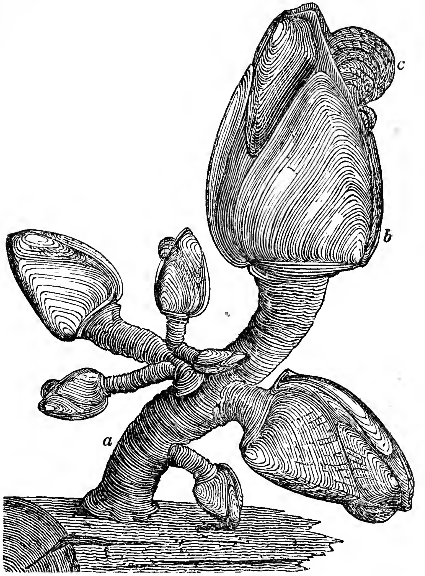
is sometimes followed by fever and sickness of several days' duration. On this account they are often called sea-nettles. It is not improbable that many animals which are not furnished with mechanical means of offence or defence are provided with poisonous secretions, on which their means of existence depend. In the common, or green polypus, (the celebrated polype of Trembley), the tentacula or arms are well adapted for seizing its prey; but no sooner does the worm touch the lips of the polypus than it expires, though no wound whatsoever has been made. Fontana supposed the polypus to be possessed of a powerful venom.*

Should it happen that some plank or log of wood, which had long floated in the water, some part of a wreck, or a trunk of a tree brought down by a river and carried out to sea, were stranded among the rocks, we might have the satisfaction of finding attached to it several interesting species of shells, especially the barnacle shell. This is a multivalve, that is, it is composed of more than two pieces. It stands upon a fleshy contractile pedicle, and from the opening of the shell a number of very beautiful dark-brown feathered tentacula protrude. The following figure (12) will render any farther description unnecessary.

The history of this little shell-fish affords a striking example of the readiness with which errors and absurdities are adopted, if they be at all connected with the marvellous. At one period it was an accredited opinion among all classes, as it still is

* Adams on the Microscope.

Fig. 12.



Lepas *anatifera*, barnacle shell; *a*, the pedicle; *b*, the shell; *c*, the tentacula.

with the vulgar, that the bird called the barnacle was produced from this shell; and on what grounds? simply because the nest of the barnacle was unknown; and the tentacula of the shell-fish bear a resemblance to feathers. But if the shell produced the barnacle, its own origin was not less remarkable. Gerard, in the 1391st page of his Herbal, or "Historie of Plants," closes that great work with a description of this "woonder of England." — "Having travelled," he says, "from the

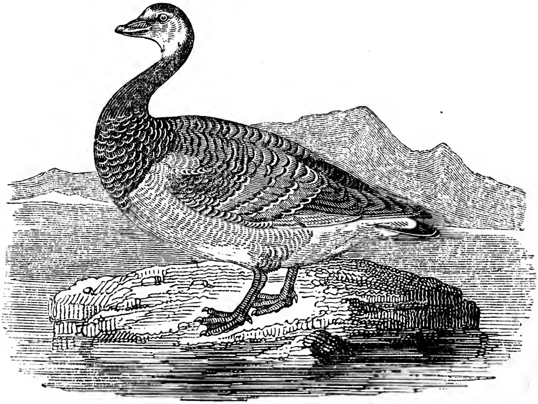
grasses growing in the bottome of the fenny waters, the woods, and mountaines, even unto Libanus itselfe; and also the sea, and bowels of the same; we are arrived to the end of our historie, thinking it not impertinent to the conclusion of the same, to end with one of the marvels of this land, (we may say of the world); the historie whereof to set foorth according to the woorthiness and rarity thereof, woulde not onely require a large and peculiar volume, but also a deeper search into the bowels of nature than my intended purpose will suffer me to wade into, my insufficiencie also considered; leaving the historie thereof rough hewen unto some excellent men, learned in the secrets of nature, to be both fined and refined. In the meane space take it as it falleth out, the naked and bare truth, though unpolished: There are founde in the north parts of Scotland, and the islands adjacent, called Orchades, certaine trees whereon doe growe certaine shell-fishes, of a white colour, tending to russet, wherein are contained little living creatures; which shels, in time of maturitie, doe open, and out of them grow those little living things, which falling into the water doe become fowles, whom we call Barnakles, in the north of England Brant Geese, and in Lancashire Tree Geese: but the other that do fall upon the land perish, and come to nothing. Thus much by the writings of others, and also from the mouths of people of those parts, which may very well accord with truth."

"But what our eies have seene, and hands have touched, we shall declare;" and then he goes on, in all the confidence of entire belief, to describe

the different stages by which the fish is changed to the bird; as that, when the latter is formed, the shell gapes; then the legs hang out; then the bird still growing bigger, the shells open more and more, till at length it is attached only by the bill, soon after which it drops into the sea, "where it gathereth feathers, and groweth to a fowle bigger then a mallard, and lesser then a goose." You will find the following lines, from Du Bartas, expressive of this history, in Walton's Angler:—

> "So slow Boötes underneath him sees
> In th' icy islands goslings hatch'd of trees,
> Whose fruitful leaves falling into the water
> Are turn'd 'tis known to living fowls soon after.
> So rotten planks of broken ships do change
> To barnacles. O transformation strange!
> 'Twas first a green tree, then a broken hull;
> Lately a mushroom, now a flying gull."

Fig. 13.



The Barnacle.

The absurd transformation here described was, at one period, believed all over Europe, as indeed were many things even still more improbable. Ivy was thought to grow out of the horns of living deer; asparagus from the horns of a ram; flies were produced in the copper furnaces of the island of Cyprus, which could only live in the fire, and died immediately on being taken from it; insects were thought to be generated by putrefaction; the mud of the Nile was changed into innumerable living creatures; and even frogs and leming-rats were thought to be formed in the clouds. These errors, however, while they are proofs of the great credulity and ignorance which have prevailed in the world, did not, at any time, tend to lead men to the commission of crime. But there were transformations of an equally or more absurd character believed in, which did lead to the most infamous persecutions and murders; I allude to the belief in witchcraft. When a woman, bowing underneath the weight of years, living in poverty, and without friends, was suspected of being a witch, it was thought that she had an imp obtained from the devil ready to obey her commands; and that she had the power of transforming herself into an animal, especially a cat or hare, and every misfortune which happened to her neighbours, or in the village, was ascribed to her agency. Could it be believed that, even in the British islands, thousands of unfortunate beings have been tortured, and burnt to death, through a belief in this impossibility? We are more wise and just at the present day, because knowledge and science have greatly

increased; for in proportion as a people become more enlightened by science, do persecution and superstition decline. There are still, indeed, believers in dreams, spirits, omens, charms, fortune-telling, and other similar nonsense; but I suspect they are much on the decrease; and I would have you to recollect, that whenever we imagine things to take place contrary to the laws of nature, we are sure to be getting deep in error. Suppose now that you had been born in Turkey, and been educated a true Mussulman, it would be necessary for you to believe many absolute impossibilities, which, not having been so educated, you can now laugh at as being most ridiculously absurd. You do not believe that Mahomet, in one night, went from Mecca to Jerusalem, and then before morning paid a visit to heaven, and held a conversation with God; nor that the angel Gabriel revealed to him the secrets of his enemies, and brought to him, from time to time, the chapters of the Koran: you do not believe that he saw the moon cut asunder, nor that he hid that satellite in his sleeve: you do not believe in his paradise; you laugh at the supposed efficacy of a pilgrimage to Mecca; but these, and many more incomprehensible and unnatural things, you would have to believe in had you been born at Constantinople, and your parents been true followers of the Prophet. Among the first ideas impressed on your infant mind would have been, that eternal suffering would be your lot after death, if, during life, you did not perfectly rely on the truth of the Koran; and the first words you would have been taught to read, or commit to memory, would have

related to doctrines taken from that book, which they would have made you to believe was given to Mahomet by God himself.

Had such been your education; had such ideas been impressed on your mind from the earliest dawn of thought and memory, the longest life, independent of the perpetual prayers, ablutions, and ceremonies of the Mahometan church, might not serve to discover to you the cheat; but with the constant repetition of these, with the means of temporal advantage which the real or affected zeal for them is calculated to afford, with the reputation of being pious and a favourite of Heaven, and with the many other advantageous *et ceteras* which zeal secures in Mahometan as in too many other countries, it would not be easy for you to see the real truth. Indeed, you would shudder, or feel the highest indignation, at the book or creed of your early initiation being hinted at as containing any thing but the truth, and that the most important of all truth; so that, as an honest man, you would continue simply in error, or, as a fiery zealot, you might persecute to death, if in your power, all who should presume to deny the everlasting truth and divinity of the Koran. As a champion of the holy faith it propounds, you might cheat, lie, persecute, be arrogant, be cruel, be blood-thirsty; but having the faith, believing in the Prophet, having your trust in the sacred book, in the holy Koran, having fought for it, having persecuted for it, having in every shape sinned for it, having murdered for it, having extirpated heretics, having spit upon Christian dogs, having fought, and hoisted the crescent above the

cross, and all for the Koran, you would consider that you had made out a fair title to pass the bridge al Sirat, to drink the water of the river of paradise al Cawthar, after which the blessed feel thirst no more, to enter heaven, whose gravel is of pearls and precious stones, and its trees of solid gold, to live for ever with fifty houries or girls of paradise, and reside in palaces sixty miles long and as many broad, and each formed of one single pearl. Had you been born and bred a Turk, such you would have expected as the reward of your *faith* in the Koran, and of the zeal displayed in your exertions for its propagation.

When I commenced the present letter, I had little idea or intention of adverting to subjects of this kind; but I must claim the privilege of digressing, even though I should sometimes wander a little too far from my immediate subject. But I write for your good, I hope. I wish to impress on your mind a conviction that it has the undoubted privilege of thinking for itself, of investigating the truth of opinions, and rejecting what it cannot but know to be false, no matter by what authority it may be enjoined. If the Koran stated that Mahomet had sliced a piece from the sun and cut it into fragments to form the stars, what good Mussulman would doubt it? what Mussulman would dare to doubt it? He would suffer for his infidelity in this world, and after death would, in the opinion of all true believers, be condemned to the Mahometan hell, the very lightest punishment of which is to be "shod with shoes of fire, the fervour of

which will cause his skull to boil like a caldron." * To possess the courage of thinking for one's self is, in my humble opinion, of inestimable value: to be bowed down under the mental tyranny of others; to be obliged to acknowledge a belief in what reason and nature teach us to know is false; to have to subscribe to opinions which in our consciences we must doubt, or think erroneous, is a most miserable slavery; and to submit, without exercising our own powers of thought, is to become spontaneously, willing and cowardly slaves ourselves.

Among the animals which inhabit these rocks are the limpet, which adheres by forming a vacuum, (as I shall have to explain at another time,) the periwinkle, and the lobster. The last is among the most remarkable of animals; I shall not attempt to describe it, but I recommend to you to examine attentively the first you see. Observe its pedunculated eyes, its long and numerously-jointed horns or antennæ, the additional pair of smaller horns, each bifid, or divided into two; the jaws, the serrated snout; the difference between its two larger claws; and, above all, the arrangement and articulation of the plates which cover what is usually called the tail. These moveable plates are joined together by a most admirable mechanism, which you must examine yourself, for I shall not attempt to describe it. But what is this mechanism for? You know there must be a design in it; what is the design? Why has a lobster this disposition of parts more than a crab? These ques-

* Sale's Koran, Prelim. Discourse, p. 127.

tions I shall attempt to answer; but, from the imperfection of our knowledge of the history and manners of the animal, I cannot do so to the full extent that I could wish.

The muscles, then, which act upon these moveable plates, have prodigious power, and by one sudden contraction they will cause the lobster to fly backwards with the velocity of an arrow. This forms its means of escape from its enemies. When, while it is in search of food at a considerable distance from the hole or cleft which it inhabits in the rock, any cause of alarm occurs, it immediately expands the plates which form the true tail, and then contracting the muscles, the tail is brought downwards and forwards with immense force, is flapped up against the lower part of the body, and from the impulse thus given the animal darts backwards with extraordinary swiftness, and will thus throw itself into its retreat, though the latter may be barely wide enough to admit of its entrance.* The repeated relaxation and contraction of these muscles operating on the tail-plates must make the lobster move backwards with inconceivable rapidity, and, in fact, when employing this species of motion, the eye can scarcely follow it; it passes like a flash.

When you have examined the wonderful workmanship which even the *shell* of the lobster exhibits, consider what an astonishing production the whole animal is; without a knowledge, however, of the general anatomy, you cannot have adequate conceptions on this head; keep, therefore, to the

* See Pennant, Brit. Zool. vol. iv.

structure of the shell, and reflect on the mighty power which, with such ease, produces an object of so elaborate and complicated a mechanism. A female lobster will lay from twelve to twenty thousand eggs, and each of these, if undisturbed, would grow to be as perfect as the parents. Look at the specimen before you: think of the time, the labour, the ingenuity which would be required to make even an imperfect resemblance of it in wood or any other material; of the number and variety of the joints; of the perfect adaptation of the different parts to each other: but it is too complicated for me to mention all the wonders of its formation. The egg of the lobster is not larger than this letter (o); how strange that such an atom should have a power of becoming evolved into so complex, so strange, so admirable a piece of work as the lobster itself! But I must not conceal, that, to most persons, this animal has a very uncouth appearance, which is chiefly owing, I suppose, to the apparently disproportionate size of its large claws. One, indeed, would think that these would be difficult to manage; they have the appearance of an incumbrance, rather than of a useful and well-contrived appendage; but you are now sufficiently satisfied, I presume, that, notwithstanding appearances, the works of creation are all perfect in their kind. I have a very confined knowledge of the manners and mode of living of the lobster, but I have little doubt, that could I see it in full action in its native element, I should have a very different view from what it presents at the fishmonger's stall; and I am satisfied, that in that situation the claws

would seem any thing but an incumbrance. On examining the nippers of the larger claws, you will find their margins knobbed or tuberculated, while the margins of those of the smaller are toothed or serrated. Mr. Travis says, in the British Zoology, that, "with the former it keeps firm hold of the stalks of submarine plants, and with the latter it cuts and minces its food very dexterously." It is known that the lobster is very voracious, and also omnivorous; and it may perhaps be, in a certain degree, compared to the vulture among birds, as being a kind of scavenger for clearing away putrescent substances. It seems even to prefer flesh in a state of corruption, to that which is fresh. Mr. Montague states, in the second volume of the Wernerian Transactions, that immense quantities of the ray-tribe of fishes are destroyed as bait for catching crabs; that perhaps not less than forty tons are brought ashore, in one season, at the small village of Torcross, on the south coast of Devonshire; and that the reason of this vast consumption is, that the crabs will not enter the pots when the bait is in the least degree tainted. Lobsters, he remarks, "cannot be taken but by bait *in a state of putridity*." The great size of the claws may, then, be requisite for tearing the flesh of carcases, and we know that the force which they exert is immense. May it not also be, that when the lobster makes its spring backwards, the length of lever of the claws, combined with their weight, will serve as a counterbalance to the impulse given by the tail, and prevent the animal being thrown over on its back?

I think it probable, that of the many sea-weeds which are to be found among the rocks we are visiting, you may be only acquainted with the Dulse or Dillisch. It is the Fucus *palmatus* of Linnæus, the trivial name being taken from the frond or leaf having a distant resemblance to a human hand. It grows in abundance both on rocks, at low water mark, and on the stems of the tangle, which are often completely clothed with it. In Scotland it is usually eaten, I believe, when fresh, but it is much better dried. In the process of drying it acquires a very sweet odour, not unlike that of violets. When it grows on rocks, if my observation be correct, it does not attain the size which it acquires on the tangle, but it is more delicate, and a better esculent. I believe that when other fuci or sea-weeds grow on the tangle, they also become larger than they are found elsewhere, and it may be that they absorb nourishment from it. The fucus crispus is a species found plentifully on these shores, growing on rocks and in pools. When bleached white, and well boiled, it forms a fine jelly, which is now used under the name of Irish moss, as a nutritious light food for invalids and sick persons. But we shall leave the rocks, and bend our course to the sandy shore, and there give our ideas such range as time and circumstances may suggest.

LETTER XIII.

How delightful is it on a day like this to ramble on the margin of the mighty deep, and experience the happiness which a love of nature, and reflection on God, as its Author, can inspire! But the human mind is not to be satisfied with uniformity or limitation. One who from infancy has lived in the vicinity of this fair strand, who year after year has seen the green wave of summer glide on and die along the shelving shore; and who, for as many winters, has heard the tempests roar, and seen the billows burst in foam upon the rocks, and rage round the wide amphitheatre of the bay; may yet be little sensible, in either case, to the beauty or sublimity of the scene. The mind must have variety; for, in time, the impressions made by the most beautiful objects will become faint, or at least we lose the habit of frequently thinking of them. But in the study of natural history there is perpetual novelty, an interest that never dies, a happiness which never satiates. Let us walk by wave-worn shores, or climb hills and mountains, or thread the mazes of romantic streams, or wander through woods, or by the margin of lakes, the mind imbued with knowledge and a love of nature finds constant cause for admiration. No bud that blows, no fly that hums its little song, no bird that cleaves the air, nor fin which cuts the lucid wave, but tells to it the wondrous works of the Almighty. It is

not, however, you will remember, the act of retiring into solitude, of living in deserts, nor of moping through "glades and glooms," that will form a naturalist, or a true lover of nature. He, however much he study nature in nature's self, is the last man living who would become a hermit. Various circumstances may induce persons to retire for a time from society, to brood over feelings which they would hide from the world; to mourn for the dead, or to recover the shock brought by an unexpected reverse of fortune. This is human nature; but it is not human nature to abandon society and turn eremite, under the idea of thereby pleasing the Deity. This is the result of self-deception, of degrading notions of God, of arrogance and self-conceit, and often of knavery combined with these; or else of insanity, brought on by their excessive indulgence. Man is in his nature a social being; God has made him so; and when he deserts the interests and society of his species, under the notion of serving his Maker, he is thwarting one great end of his creation. In truth, however, the hermits of whom we read had often any thing but solitude and devotion in view, when they retired to live in caves and dirt: many did so to gain a name, to obtain a consequence in the annals of their superstition, and to extort money from the fanatics who were imposed on by their tricks; and what is perhaps still more to be deplored, some were in absolute earnest, and did really think in their consciences that they were serving God, and yet could not fairly be said to be out of their proper senses.

A naturalist, I grant you, loves the country; it

is the temple in which he best feels his pursuits; but still, what were the country without the town? It is when men congregate in cities that the arts and sciences flourish, that knowledge increases, that commerce extends, and discoveries are multiplied. Do not give ear to those who cry up the country at the expense of the town; some prefer the one to the other; some love the country, some the city; but both are good, and let neither be disparaged. The city has been the true source of civilisation; it is the point of attraction, the focus in which the rays of science diffused throughout the world are concentrated, and whence they again emanate and convey the blessings of knowledge to the most distant recesses of the country.

But the tide is now beginning to rise. What is the cause of that phenomenon? what produces the alternate ebb and flow of this vast mass of water which take place so regularly twice every four-and-twenty hours? Is it an operation of the sea itself, or is it owing to an influence extending from distant worlds? You know that it is the latter, that it is caused by the attraction of the sun and moon. And what is this attraction? No one can tell; we only know it by its phenomena; we know that it exists; that by its influence the worlds throughout the universe are guided in their revolutions; that if this influence were withdrawn the creation would run rapidly into ruin. The planets and suns would start from their orbits; the beautiful regularity of their motions would cease, and they would fly at random and in disorder through the wilds of space. Yet we know nothing of gravi-

tation itself; we know it only by its laws; we know that it extends to the most distant stars, and that, perhaps, there is not a single celestial orb which is not connected by it to the others; but what its essential nature is we can have no conception. And how many other things are there which we know only by the phenomena they present? What is the electric fluid? I cannot tell: I am aware that it causes the thunder and lightning; that it will strike a tower, and split it from the top to the bottom; that it kills men and animals; and that I can collect it by means of a machine, and exhibit it in a variety of beautiful experiments; but, after all this, I know not what the electric fluid is. And what is magnetism? Why does a loadstone attract iron? Here also I am ignorant. Why does a magnetised needle point to the north? I know not; but I know, that by its having such a property, that wide ocean before us can be traversed with as much certainty, andvastly more advantage, than if its place were occupied by solid earth. Some writers have objected that the globe on which we live has an undue preponderance of sea; but this is another example of human presumption. If it had come by chance it might have been too great or too small; but if our world was made by the Almighty (and what else *could* have made it?) it must be as he intended, and therefore it must be right. But what is the fact? Could we have communicated with distant countries by land as we do by sea? Could we have brought the produce of the Tropics to the Thames? Could we have compassed the earth from east to west,

and from north to south? Could we have calculated on the time in which we should reach the Antipodes? Look at Africa and New Holland, and see how difficult it is to penetrate into the interior of those countries. On a little reflection, indeed, you will perceive, that were it not for the vastness of the ocean we would be in great comparative ignorance of the earth, and that its great extent of surface is another proof of the wisdom with which all is planned.

Besides gravitation, electricity, and magnetism, there are many other things which we know to exist, but of whose essential nature we are altogether ignorant. Take mind, for example: is it material or immaterial? There has been much discussion used, and much argumentative acuteness displayed about the settlement of this question, but it will never, I presume, be settled in this world. And what then? What is it to you or me, or to any one else, whether it is material or not? Look at the surface of that glassy wave, the light of which dazzles our eyes as if it came from a silvered mirror; where does that light originate? O, you will say, it is only the sun-beams. To be sure: you admit, then, that the light from the wave does not originate in the wave itself, but that it comes from the sun? Yes. Well, as it comes from the sun, let me ask what distance has it travelled? how far is the earth from the sun? Ninety-five millions one hundred and seventy-three thousand miles. A pretty long journey, you will confess; but is the light tardy in accomplishing it? No; it travels at the rate of nearly two hundred thousand miles in a second, and,

consequently, arrives at the earth from the sun in about eight minutes. Does it travel farther than the earth? For what we know, it may travel on for ever, till intercepted by some opaque or ponderable object; but we know for certain that it reaches Herschell, the most distant planet of *our* system, which is no less than eighteen hundred millions of miles from the sun. Now, is light material? I have no knowledge of it but what is obtained through the medium of sight; no other sense recognises it; we cannot taste it, we cannot smell it; and it makes no impression on the nerves of touch. But I can learn that it is not only compounded of three primary coloured rays, but also of others not connected with colour at all, of calorific, and of oxidising and deoxidising rays. I can see that it is necessary to vegetation; that plants deprived of its presence lose their green colour; that it effects various chemical decompositions; and that it is subjected to certain fixed laws, which form the basis of the science of optics. From these circumstances, I infer that it is matter, that it is a substance; but how subtle must be the nature of a substance whose particles can move in every direction without interfering with each other; which can travel above 95,000,000 of miles in about eight minutes, and yet not exert the least perceptible force of collision; which will pass through the hardest crystal or the purest diamond, with as much ease as through air or water? It is imponderable, and wants various properties which philosophers have thought to be essential to matter; but, in fact, we can seldom tell what is essential to

any thing. We see objects and light by the eyes: this you will admit; and you will admit, also, that without organs of vision we could have no knowledge of light and colours. But is it the eye that sees? Consider now. You say Yes. I say No. When you take up a telescope and look at the moons of Jupiter, you see those moons, which, without the telescope, you could not see. But does the telescope see them. You laugh, perhaps; you think the question childish. It is not so. Suppose a card were slipped in between your eye and the eye-glass, you would then neither perceive the planet nor his satellites. Now the eye is to vision what the telescope is; it is an optical instrument; it serves to form an image; but the eye itself does not see; it is the organ of communication with light, and is necessary to vision, but the sensation lies in the brain, or rather, I should say, in the mind, which inhabits it. Cut off the communication between the eye and the brain, and the same result follows as when a card is placed between the eye and the telescope; all is dark. The optic nerve is the cord through which the brain communicates with the eye, and when, by disease or other means, that nerve or its expansion, the retina, on which the images of external objects are painted, loses its function, or if, as has been often proved by experiment, the optic nerves be cut across, then the animal sees no longer, though the eyes themselves remain as perfect as before.

Now, with regard to mind, I would ask, Suppose it to be even more attenuated than light, may it not still be material? It may, or it may not; God

is the only judge of this; no man can tell; and the truth is, no man needs care what the essential nature of our soul is. We know that we have a mind, a thinking principle, something independent of, though intimately connected with, organisation. The eye conveys the forms and colours of external objects to the brain, we cannot tell how, indeed, but the eye does not see; and the brain conveys these impressions to the mind; but the brain is as blind as the eye, though it is the organ of communication with the mind in its essential form, whether material or immaterial. We know nothing, and can know nothing of the ultimate nature of mind, but it seems to be a *natural* feeling that it is immortal; it is a persuasion found in almost every nation, and it is a conclusion which natural religion inevitably brings us to. I believe that the study of God in his works stamps an irresistible conviction on us that there is a future state, and that our present pursuits are only preparatory to others of a superior order, when we shall receive higher capacities, and have more extensive means of seeing and understanding the works and ways of the Almighty. But he only can understand *how* we shall exist, for we can now only know mind, like light, by its present phenomena: but we see all the parts of nature in connection, her different kingdoms joining by imperceptible degrees, so that it is impossible to tell exactly where one ends and another begins; and we also see that the worlds which form the heavens are all connected by the unseen tie of gravitation; nothing is isolated, all is in harmony and union. And is the mental world not so too? Can we believe

that the mind, like a taper, will die out and be lost for ever? That it is merely a temporary result of organisation; that it grows with the brain, and with the brain ceases to exist? We see, indeed, that the cerebral mass and the mind are so intimately united, that the state of the former uniformly influences that of the latter; that the brain and the mind are developed together, and together decay; that when brain is perfect so is mind, and *vice versâ;* and that when the organisation of the brain is injured by disease or deteriorated by age, insanity or second childhood is the result. But let us not be deceived by this; the brain may still be the organ merely of mind, as the eye is of vision. If, in old age, the humours of the eye lose their transparency, it may become unfit for its office, but *light* does not the less exist; and in the same way, when dotage comes on, the brain does its duty imperfectly, but *mind* may still be in its real nature as perfect as ever, though the bodily organ has become unfit for it to operate with. But I will quit this subject, by remarking, that however much we may argue, whatever doubts and uncertainties may arise, whatever may be told by speculative theorists, we know nothing of mind but by its operations. If a particle of light travel two hundred thousand miles in a second of time, the disembodied soul may, with equal velocity, fly to its future place of abode in the illimitable concave around us. As the most distant orbs are connected by gravitation, so it may be that, between mind and the Omnipotent Creator of all, there exists a connection as powerful, as certain, and possibly more permanent

than the attraction between worlds and systems. Without the eye we could know nothing of light, and without the brain we could know nothing of mind; but the eye is not light, nor the brain thought. They are both but organs. God is the source of light, and the source of mind, and he alone can truly know either. Let us, therefore, leave the settlement of these insoluble difficulties to him, for our faculties in this life are incompetent to the task. All things, I doubt not, will at length be made plain; and in the mean time let us be humble, let us be grateful for the powers we enjoy; let us be anxious for truth; and let us lay opinions, merely as such, aside; let us cultivate all moral virtue; let us adore the Almighty; and let us give up disputation and wrangling about things which he alone can understand.

LETTER XIV.

The Great Crested Grebe.

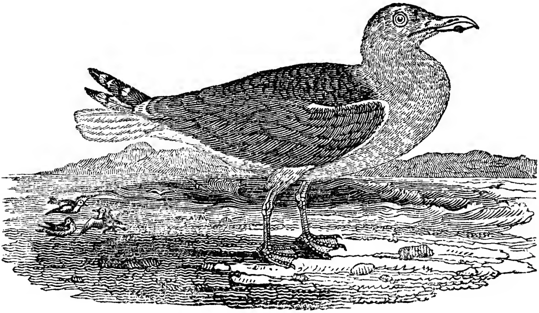
Fig. 14.

On looking seaward, we may now observe flocks of sea-gulls, whose snowy whiteness forms a dazzling contrast with the blue waters on which they float. The cormorant also produces a contrast equally strong by its blackness, when it appears on the surface, but it is as often withdrawn from observation, having plunged into the deep after its scaly prey. The wild note of the godwit, as it speeds on

rapid wing to another part of the shore ; the louder cry of the curlew, which, high in the heaven, pursues its aërial voyage, and the piercing scream of the heron, which the coming tide has driven from his solitary stand, add animation and interest to the scene; and were it my object to enter into the natural history of these birds at length, you would perhaps find amusement, as well as information, in the detail. There are few subjects of observation more pleasing and instructive than that of the different adaptations of the structure of animals to their appointed modes of life. We see in the economy of them all such a depth of knowledge, such a wisdom of design, such a power of accomplishment, as is truly worthy of our highest admiration and most sober reflection. Let us even consider so simple a subject as the foot of a bird. Every part of nature being peopled with inhabitants, we find that as the bosom of the sea abounds in the finny tribes, its surface forms a resting place for many families of the feathered creation. The numerous species of gulls, many of the duck tribe, the auks, the guillemots, the petrels, the divers, the cormorants, the goosanders, and various others, people the rocks and precipices, obtain their food in the ever restless waves, and many may in truth be said to have their "home upon the deep." The foot of a bird is always adapted to its mode of life. If any of these sea-birds had a foot like that of a common fowl, a crow, a magpie, or a pigeon, it would not have served well for swimming, and hence we see that they are web-footed, like the duck or goose. Their mode of living, however, is not

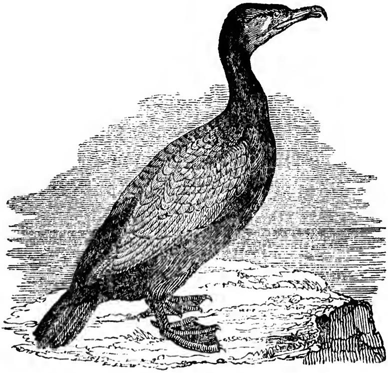
in all cases the same, and in order to meet the different circumstances in this respect, there are correspondent variations in the foot; relating to its form, the degree in which it is webbed, the comparative length of the leg, or some other particular (*fig.* 15.) for example, represents the black backed

Fig. 15.



gull, and (*fig.* 16.) the common cormorant. Both

Fig. 16.



swim, and both have webbed feet, yet there are several points of difference between them. Why are the feet placed so much farther back in the cormorant? They are so much so, that the bird, as you see, stands nearly erect. The reason is this: the Deity has determined, in his wisdom, that the one bird should seek its food *on* the surface of the water, and the other *beneath* it; that one also should feed while on land as well as water, but the other in the water exclusively. Now, the gull cannot dive, however well it can swim; and in consequence it can only obtain such prey, or edible substances, as are to be found floating on or near the surface: but the cormorant subsists on fishes, which it pursues under water; and the backward position of the legs, it will be evident, must assist it most materially in diving after them. You will observe a difference, too, in the manner in which the foot is webbed in the two species: in the gull, the back toe is very small, and not connected with the others; while in the cormorant, it is not only of considerable length, but is united by a membrane to the other three (as you may observe in the off foot of the figure), so that, in this bird, the whole four toes are webbed and connected together, — a circumstance which tends to give great velocity to it when diving in pursuit of prey. Montagu, speaking of a tame cormorant, observes that "it is almost incredible, to see with what dexterity this bird dives and seizes its prey: knowing its own powers under water, if a fish is thrown in at a great distance, it frequently dives immediately, and pursues its course under water in a line to the spot it was observed

to fall, with vast celerity; and if the water is clear, takes the fish with certainty, and frequently before it falls to the bottom." But in the natural state, how does the cormorant know where the prey is? If you were in a boat, even on the calmest day, you could not see a fish at a distance of twenty or thirty feet, and ten or twelve below the surface, and still less if there were any breeze or ripple. Now, how does the bird manage? The author just quoted states, that when fishing, it always keeps its head *under* water, in order that it may the more clearly and certainly discover the prey.

There is still something more in the foot of the cormorant; but I must first explain to you what the foot of a bird really means, for, anatomically speaking, it consists of more than the part merely on which the bird rests. Observe a common fowl walking about, — where is its leg? You point to the pillar covered by a scaly skin, which stands between the toes and the feathers. Now, suppose that this fowl submits to the usual fate of its race; that it is killed and dressed, and that I request you to help me to a leg. Do you find any difference in the part you send me from what you considered as the leg in the living fowl? In fact, you help me not to the leg only, but to the thigh also; while the naked part, which you considered as the leg in the living bird, is wanting altogether. From this you will see, that what you had considered as the knee, is in reality the ankle or heel; that what is commonly called the drumstick, is the leg; and the portion above it, which is attached to the side bone by the round ball, or head of the os femoris or

thigh-bone, is the thigh. A similar mistake is often made respecting the legs of the quadruped: for what in the cow is called the hock, is really the heel; and what is called the knee in the horse, is either his wrist or ankle. The proper name for the naked part of the leg in the fowl is the *tarsus*, and it is to be considered as part of the foot; for though only a single bone, it is the analogous part, with certain bones, seven in number, which in the human foot go by the same appellation, and also of the five bones which compose the metatarsus. It exists in all birds, though it varies exceedingly in length. In some, too, it is covered with feathers; as in many of the hawk tribe, in the owls, and in the grouse. In many also, especially those called waders, the lower end of the true leg is bare of feathers; as in the heron, bittern, spoonbill, curlew, godwit, and many others. It is not, then, the part being bare of feathers, and covered with a scaly skin, which forms the distinction between the leg and the tarsus, but the heel or ankle, or, as it is usually termed, the knee-joint.

Notwithstanding this explanation, I shall still name the parts in the ordinary way; that is, I shall call the tarsus of the bird its leg, and the ankle or heel its knee; this will save trouble, and you cannot now be misled in your ideas of it. If you examine, then, the leg — that is to say, the tarsus — of a duck or goose, you will find, that though it is compressed laterally, still it has considerable thickness in front. These birds, however, do not require to swim with great velocity, and, in fact, a slow and deliberate examination and search with their bills

is the most usual way of obtaining their subsistence. But we may readily conceive that in a bird which, like the cormorant, depends chiefly for its success in capturing its prey on the rapidity with which the latter can be followed, such a leg would be less properly fitted, since it would offer considerable resistance and retard the velocity. Now, here, again, we have an example of that wisdom which pervades every thing, whether the revolutions of worlds, the motions of a fly, or the structure of a bird. The cormorant's leg is so flattened on the sides, that the anterior edge which cuts the water is not thicker than the blade of a carving-knife. Then, again, observe how the bird is adapted in other respects to its mode of life. Its compressed legs, and the rapidity with which it can pursue fish, would still avail it little, were not its beak particularly formed for holding its slippery capture. This, instead of being spoon-shaped like a duck's, is long, and has at the end of the upper mandible a sharp hooked nail, which serves admirably for holding the fish: but still something more is wanting; for however well the position of the foot, the form of the leg, and that of the bill, may be up to the point, of seizing the prey, how is the latter to be disposed of when it is captured, seeing that often it is very large, and sometimes even consists of flat-fish? This is provided for by the vast extent of the œsophagus or gullet (the tube which conveys the food from the mouth to the stomach), which will admit a fish of incredible size, compared with the thickness of the neck. The digestion of the cormorant is so very rapid, that Mr. Montagu found, in the

tamed bird already alluded to, that three or four pounds of fish were readily devoured twice a day; hence the destruction it causes must be very great. Bewick makes the following observation: — "At sea, or in the inland lakes, they make a terrible havoc. From the greatest height they drop down upon the object of pursuit, dive after it with the rapidity of a dart, and, with an almost unerring certainty, seize the victim; then emerging with the fish across the bill, with a kind of twirl throw it up into the air, and dexterously catching it head foremost, swallow it whole." *

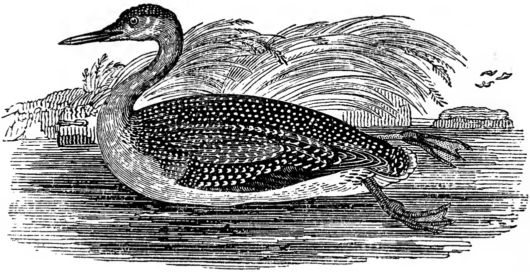
The cormorant, with all its requisites for depredation, is still liable to an inconvenience which many other diving birds do not experience; which is, that its plumage, when kept long in the water, becomes soaked, and the bird has then to betake itself to the rocks, and spread out its wings to dry in the breeze or in the sunshine. The plumage in many diving birds, on the contrary, is quite impenetrable to water; and in some species, especially in the grebes, and birds of the Colymbus genus, is so thick and silky, that their skins sell for considerable sums, and are used for forming muffs, tippets, and other articles of dress. These species, however, cannot swallow fishes of considerable size; and perhaps it may be that the plumage of the cormorant, by becoming moist, obliges it to leave the water before gorging to such an excess as might prove fatal to it. This, however, I offer only as a conjecture; but that the cormorant does gluttonise

* Bewick's British Birds, vol. ii. p. 382.

to satiety is evident, from the circumstance, that it is sometimes so much surfeited as to let itself be taken by a noose cast round its neck: its gluttony, indeed, as every one knows, is proverbial.

The following figure (*fig.* 17.) represents the

Fig. 17.



speckled diver; and you will remark how far backward its legs are placed, and how well the whole conformation of the bird is fitted for diving. In the figure of the great crested grebe at the head of this letter, and in that of the puffin, or coulterneb, at the end, you will perceive a similar adaptation. But well fitted for an aquatic life as these are, there are some species still more so; as you will find in the history of the penguin tribe, in many of which the wings are so small, and covered with such scale-like feathers, that they more resemble the fins of a fish than the wings of a bird. In these, also, the feet are placed very far back, and their action must be most powerful; but in addition, the bird, in diving, uses its wings also, just as if it were flying in air; and you may readily conceive, that, by the impulse

received from both wings and feet, the motion of the penguin through the water must be extremely rapid.

Let me now bring to your recollection what, I suppose, you have witnessed more than once — the cruel sport (as it is called) of duck-hunting. You will remember, that when the dog has got so near the duck that the latter is in danger of being seized, it plunges beneath the surface, and again appears, after several seconds, at a considerable distance from the place where it went down. The results of this manœuvre may be more than one: the dog may be bewildered, and consequently halt in the pursuit; or the duck may change the direction of its course, and on re-appearing may elude his eye, and thereby gain time. But I wish you to enquire whether a bird, in diving, will, by a similar impulse, move actually faster than it would in swimming. Does a cormorant, or a duck, or a grebe, move more rapidly *under* the surface of water than *on* it? In several parts of Montagu's Ornithological Dictionary, and the still more valuable Supplement to it, you will find illustrations on this point, showing that the same power will cause a much more rapid motion in diving than in swimming; and the cause is this: — When a bird moves in water, or upon it, there is a movement upwards as well as forward; but in swimming, the momentum upwards is lost, and the bird derives benefit only from the forward impulse. But in diving, the pressure of the water above prevents the ascending movement, and consequently the impetus is not lost, as if the bird were on the surface, and therefore the propelling power

is greater; and the bird moves faster, because, in diving, the whole moving power is effective; whereas, in swimming, a part of it is lost, and the progress is proportionally lessened.

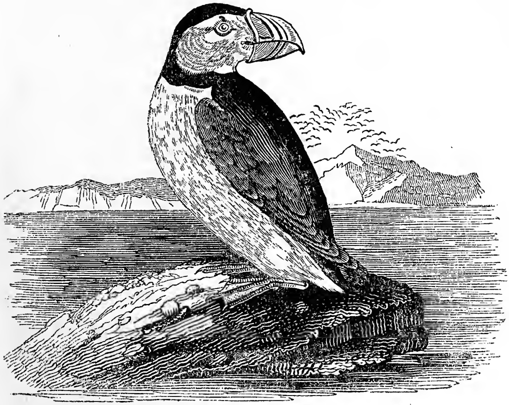
Notwithstanding the regularity of nature's works, there is at the same time scarcely any of the phenomena she presents to which there are not exceptions. Thus, although birds which swim have webbed feet, yet there are some which want that structure, and swim remarkably well; while there are others provided with web-feet, which do not swim at all. The common water-hen, which swims and dives remarkably well, is an example of the former (its toes, however, are extremely long), and the avoset seems to be an instance of the latter. "The feet of this bird," Montagu observes, "seem calculated for swimming, but it has never been observed to take the water for that purpose. We remember one of this species being wounded in the wing, and floating with the tide for near a mile, when it was taken up alive, without ever attempting to swim, so that the palmated feet seem only intended to support it on the mud."*

If you examine farther the feet of water-fowl, you will find much to interest you in considering them in relation to the habits of the different species, and, in all, you will perceive the wisdom which has directed their formation. I would advise you to investigate, in this point of view, the long naked legs of the heron and other waders; the toes of the curlews, broadened by a membranous edge,

* Ornith. Dict. in verb.

to enable them the better to walk on mud; the scolloped toes of the coot, and the whole adaptation of that bird for living in fens and lakes; the phalaropes, the grebes, the guillemots, the divers: in short, turn over the beautiful figures of Bewick, and examine the situation and form of the feet in the different species as you go along; compare these with the history and habits of the bird; and employ your mind in thinking earnestly on the Divine wisdom which has so carefully fitted them for their various offices. In my next I shall pursue this subject a little farther, as it is exemplified in land-birds.

Fig. 18.



Puffin or Coulterneb.

LETTER XV.

The division of the feathered creation into land and water birds is very convenient, though by no means so correct as at first sight, or on a superficial observation, it might appear. Many of the birds mentioned in my last letter are in every respect so decidedly aquatic, that there can be no doubt on the subject; but, on the other hand, there is a considerable number of species which want what we might consider the characteristic marks of water-birds, and yet are almost entirely aquatic in their habits. The water-hen has already been mentioned, which, though not web-footed, can both dive and swim. The oyster-catcher, also, can do both, if necessity require; and, according to the observation of the accurate Montagu, the curlew can swim, and the sandpiper both swim and dive. The water-ouzel, again, which inhabits the stones and banks of mountain-streams, though not web-footed, can pursue its prey under water; and the kingfisher, which has very small feet, also dives frequently in pursuit of the smaller fishes. The osprey, or sea-eagle, lives chiefly on fishes, which it takes by pouncing on them as they come near the surface of the sea or lake; but it does not seize them, like the kingfisher, with the beak, but with its foot, and for this purpose the latter is finely adapted. Like the other eagles, it has one back

and three front toes; but there is this difference in the foot of the osprey — its outer toe is larger than the inner — whereas, in other eagles, the inner is larger than the outer. Now, you will not at once see what great advantage can result from this; but there is something farther: the outer toe, while it is larger, is also moveable, so that, at pleasure, the bird can turn it back, in which position the foot would seem to have two front and two back toes; and it must be obvious to you, that by this disposition it will be rendered much more fit for grasping its slippery prey, than it would be without such contrivance. Mr. Montagu gives the following account of the osprey's mode of fishing: — "As we were crossing the bridge over the river Avon, at Aveton Gifford, on the 9th of April, 1811, we observed an osprey hawking for fish; at least its attention was arrested, and, like the kestrel in search of mice, it became stationary, as if examining what had attracted its attention. After a pause of some time, it descended to within about fifty yards of the surface of the water, and there continued hovering for another short interval, and then precipitated itself into the water with such great celerity as to be nearly immersed. In three or four seconds the bird rose without any apparent difficulty, and carried off a trout of moderate size, and, instead of alighting to regale upon its prey, it soared to a prodigious height, and did not descend within our view."

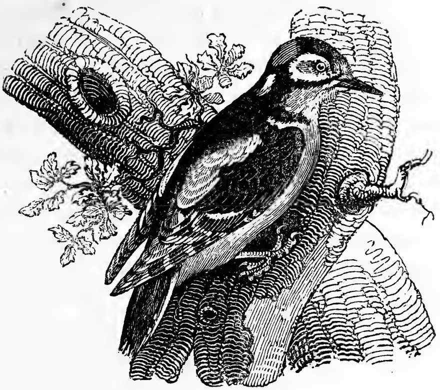
The cuckoo has a similar power of turning the outer toe backwards or forwards, but I have met with no reason assigned for this peculiarity; — it

may not be improbable, perhaps, that the cuckoo lays her egg on the ground, and then conveys it in her foot to the nest of its future foster-parent. There is a little bird called the nuthatch, found in woods in various parts of England, the foot of which is, comparatively, very large. The bird is about as big as a sparrow, yet, "when extended, the foot measures one inch and three quarters." * I know of no reason nor conjecture that has been assigned, to account for this great size; but I think that, very probably, it is intended to enable the bird to pick up and carry nuts to the chinks in the bark of trees, in which it fixes them, till, by repeated pecking, the shells are split and the kernel picked out. Bewick observes, that, "when disturbed at its work, it very readily removes the nut and flies away with it," but I have no where seen it stated *how* it conveys the nut away.

When two toes are placed before, and two behind, the foot is called a *climbing foot*, the pes scansorius of ornithologists (see *fig.* 19.), but in it there is no voluntary motion of one toe backwards or forwards at pleasure, as in the osprey and cuckoo. Many foreign species have this kind of foot; an example of which you may observe in the parrot. In Great Britain, I believe, it is confined to the wryneck and the woodpeckers. These birds live on insects; and the woodpeckers bore into the tree itself, wherever it is unsound, in order to come at the insects with which such parts are peopled. The legs are short and strong; and, by the disposition of the

* Bewick's British Birds, vol. i. p. 143.

Fig. 19.



The greater spotted Woodpecker.

toes, the woodpecker can cling to the nearly perpendicular trunk of a tree for hours; which it could not do so well with any other than the climbing feet. The adaptation of the woodpecker to the mode of life it is destined to follow has been often adverted to by authors; and, indeed, it affords a very striking example of the perfection in which all is created: let us, therefore, enquire a little farther into it. We see that the climbing foot enables the bird to rest on the trunks or larger branches of trees, better than one of any other construction; but no matter how it may be formed, we can readily conceive that the muscles of a leg of any kind will at length tire by exertion. The claws of the woodpecker are strong and much hooked, and this gives additional facility of adhering to the tree. Still, however, the legs will tire; but must the bird then

desist from its search? or is there any provision for assisting the feet, so as to relieve them and in part perform their office? Yes; the quill feathers of the tail, which are ten in number, are very stiff, and instead of being barbed to the points, are there naked and sharp; and thus they can serve as a support for the bird. When, therefore, the feet begin to tire, the woodpecker inflects its tail, so that the points of the feathers are opposed to the bark of the tree; and in this way it is supported on its tail as on a seat. The tail of the cormorant is composed of similar feathers, and is used for a similar purpose when that bird sits upon rocks. In most books where the woodpeckers are described, you will find an account of the admirable mode in which the mouth of those birds is constructed for taking their insect food: their chisel-formed bill, the vast strength of the muscles which move the head, and the singular nature of the tongue, are all adverted to; the latter can be launched out to a great extent, and is the instrument by which the bird seizes its prey. It is said that ants, and similar small insects, adhere to a glutinous fluid with which the tongue is besmeared; but whether this be so or not, there is another method by which the woodpecker takes its prey, and which forms a very striking instance of Divine contrivance, and is another example of the endless variety which characterises the works of the great Fabricator of all. The mode of capture I allude to is this: — The bird takes insects by transfixing them with its *tongue*, that is, not by glueing them to the mucilage covering it, but by thrusting its tongue through them. There

must be some unusual structure to effect this; and I suppose you anticipate what that is. The tongue is not fleshy throughout, but terminates in a horny thorn-like point, which will plunge through the body of an insect like a dart or javelin. But there is more than this: many insects are very strong, and so tenacious of life, that, even though transfixed with this formidable weapon, they will struggle most violently: why, then, do they not slip off it? They cannot, on this account: the horny portion is not smooth on its sides like the end of a needle; it is barbed like a harpoon, and hence the insect cannot disengage itself, however much it may struggle during the little time that is allowed it to do so. Now, here another question arises: when the tongue is drawn into the mouth, with the insect impaled upon it, how does the woodpecker itself get it disengaged from the barbs, so that it may be swallowed? In Bewick's "British Birds" it is stated, on the authority of a letter from J. E. Bowman, Esq., that in the back part of the palate there is a longitudinal groove, having a fringe of hairs pointing backwards; and it is supposed that in detaching the transfixed insect the horny end of the tongue is pointed to the back of the throat, and then being brought forward into its usual position, the fringe detaches the prey from the barbs. If this explanation be correct, it affords an admirable example of that Divine contrivance to which I have so often referred you.

The life of the woodpecker might, on a superficial view, seem to be one of toil, and to be particularly marked by a destitution of enjoyment.

Such (as might have been expected) is the picture which Buffon has drawn of it. "Of all the birds," he says, "which earn their subsistence by spoil, none leads a life so laborious and so painful as the woodpecker. Nature has condemned it to incessant toil and slavery. While others freely employ their courage or address, and either shoot on rapid wing, or lurk in close ambush, the woodpecker is constrained to drag out an insipid existence in boring the bark and hard fibres of trees, to extract its humble prey. Necessity never suffers any intermission of its labours — never grants an interval of sound repose; often during the night it sleeps in the same painful posture as in the fatigues of the day. It never shares the cheerful sports of the other inhabitants of the air; it joins not their vocal concerts; and its wild cries and saddening tones, while they disturb the silence of the forest, express constraint and effort. Its movements are quick; its gestures full of inquietude; its looks coarse and vulgar." * From what I formerly said respecting the distorted views often taken by this author of the state of animals, you will, I suppose, attach no credit whatever to this melancholy picture. We are very apt to calculate the degree of misery which an animal may undergo, by imagining what we ourselves would feel under similar circumstances; but it is peculiarly unfortunate that this sort of comparison is not adopted in the only instances where it could be attended with good, — that is, when the animals around us are undergoing pain and de-

* Wood's Buffon, vol. xviii. p. 2.

privation from our own tyranny and oppression. If in these cases we would imagine ourselves in their place, and think of the misery we should experience by such change of situation, it might be a powerful motive for our attempting to mitigate their sufferings.

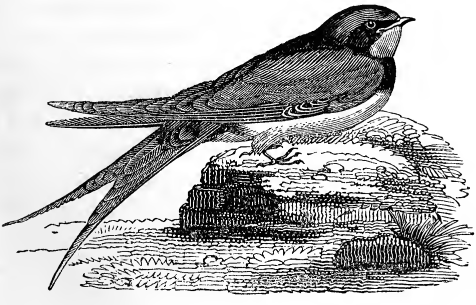
But in a state of nature no race of animals is unhappy; they are all adapted to the mode of life which God has ordained them to lead; and their chief enjoyment consists in pursuing their natural habits, whatever these may be. The woodpecker, while boring a tree, and clinging to it for hours by its scandent feet, is just as happy as the eagle is when perched upon the mountain cliff, or pouncing on its quarry from the clouds. Neither could lead the life of the other, but each is happy in the state which has been assigned to it; and this is observable throughout all nature. A rat, which burrows in a ditch, is as happy as it could desire, so long as it can find garbage sufficient to feed on; and a heron, immoveably fixed watching for the approach of small fishes and frogs, has, there can be little doubt, as much pleasure as any lover of the angle can enjoy while wearing out the summer day in marking his light float, and waiting in mute expectation the wished-for bite.

We generally, I believe, connect rapidity or slowness of motion with the ideas we form of an animal's happiness. If, like the tortoise, it move with slow and measured steps, we pity or despise, as the mood may be, its melancholy sluggish condition; and the poor persecuted toad has probably incurred as much of the odium so unjustly attached

to it, by its inactivity, as by the supposed loathsomeness of its appearance. On the other hand, enjoyment seems to be always the concomitant of celerity of motion. A fly dancing in the air seems more happy than the spider lurking in his den; and the lark singing at "heaven's gate" to possess a more joyous existence than the snail, which creeps almost imperceptibly upon a leaf, or the mole, which passes the hours of brightness and sunshine in his dark caverns under ground. But these and all other animals are happy, each in its own way; and the habits of one, constituted as the creatures are, could form no source of felicity to another, but the very reverse. Though activity may simulate the appearance of superior enjoyment, we may conceive that where it is excessive, the animal in which it is so demonstrated must suffer much from fatigue. This would be another mistake, in so far as relates to animals in a state of nature. You are aware, as I have repeatedly told you, that the works of God are all perfect in their kind; but if an animal were formed to lead a life of almost perpetual motion, and that motion were accompanied or followed by fatigue, the work would be imperfect: take the swallow as an example; it is constantly upon the wing, except at night. You have known this bird all your lifetime, and, therefore, are well acquainted with the rapidity and constancy of its flight. From the early morning till the downgoing of the sun, it is for ever dashing through the air with the rapidity of an arrow, but neither morning nor evening does it ever show one symptom of weariness; it has a wing which never tires; and at night it betakes

itself to repose, not worn out by the fatigues of the day, but prepared for sleep after what is to it merely a wholesome exercise. The swallow lives on insects, which it takes, as it flies, with its mouth, the beak of which is very small, and the gape extremely wide; thus fitting it perfectly for the capture of its prey, and requiring no assistance from the feet. The swallow requires no particular position of the latter, as in the water-birds, for it neither dives nor swims; it does not want long legs, like the heron, for it has not to obtain its food by wading and patiently watching for it; neither has it occasion for the strong and powerful feet and claws of the bird of prey, because it needs no instruments for grasping. In fact, the great requisite in the foot of the swallow is, that it shall be formed *without* those qualifications which are such wise provisions in the feet of most other birds; for what is a perfection in them, would be an imperfection in it. On looking at the figure (*fig.* 20.) you will per-

Fig. 20.



ceive that its legs are extremely short, and the whole foot disproportionately small and delicate: this forms the perfection of the swallow's foot; and in it you will recognise another of those admirable examples of Divine ordinance which are every where before our eyes, without our taking the trouble of employing a thought on the subject. In the swift, the legs and feet are so short, and the wings so long, that when it settles on the ground, which it very rarely does, it has considerable difficulty in getting up again: but there is no imperfection in this; for the air, and not the ground, is this bird's place of abode. Its feet also have the peculiarity of the four toes being turned all forwards, and of each toe consisting only of two joints. This foot, I suppose, is for the purpose of enabling the bird to cling to perpendicular surfaces, and eaves of houses.

In another native bird, the kingfisher, you will also find an example of the feet being very small, because they are not conducive to the obtaining of sustenance, and are little used by the bird in progressive motion. But we may examine what occurs in species where the chief movements are exercised, not by the wings, but by the legs. You are acquainted with the corncrake. If the swallow is almost continually on the wing, the corncrake is as regularly upon the ground: it never takes to flight, except during its migration, or when it is flushed by the dog, which is not easily effected; and when raised, it flies only to a very short distance, with its long legs hanging down. But if it be unfitted for flight, no bird can be better adapted for running: the leg and tarsus are both long; and this enables

it to put one foot far forward, while the other is far backward, by which it can take long strides; and these coming in quick succession, the speed of the bird is very great, which renders it, notwithstanding its limited power of wing, very often able to elude the vigilance both of sportsmen and dogs. It skulks through the grass, and winds and doubles in an admirable manner; and after being raised, the moment it alights again, it runs off at all speed, and is soon far from the place where the inexperienced sportsman would expect to find it. In considering the adaptation of any part of an organised being to its prescribed mode of life, it is instructive to follow up the subject, and examine what other organs or functions concur in perfecting the object aimed at; and in the corncrake we have a good illustration of this.

As the swallow is so much what one might not improperly call an *air-bird*, it will appear evident that its young cannot leave the nest until the wings are well grown, which will necessarily occupy a considerable time. The nest, too, is elaborately constructed, and thickly lined with feathers; while that of the corncrake consists merely of a little withered grass, or other herbage, put carelessly together on the ground. Now you will recollect, that though it may take a considerable time for the *feathers* of a wing to grow, the feet and legs may be early fit for use; and this we observe in the young corncrake, which follows the mother from the moment the egg is hatched. But there is another adaptation still; the eyes and sense of vision must be perfect, and this we observe to be so at birth, in

all birds which leave the nest at or soon after their exclusion from the shell. To suppose, as is so often stated, that the sense of sight always requires to be perfected by that of touch, is erroneous. When it is the will of the Almighty that an animal shall be born fitted at once to exercise any function, that function is complete from the first, and requires no experience either to bring it to perfection or to rectify errors. The young bee, for instance, up to the time it leaves the hive, has been in perfect darkness; yet the very first time it comes into daylight it launches into the air, flies far from home, collects honey from flower to flower, and, when loaded with its treasure, returns, however remotely it may have wandered, with the most unerring certainty to the hive. In like manner the young corncrakes, almost the moment they are hatched, have the use both of their legs and sight so perfect, that it is almost impossible to catch them in the grass.

I will detain you with only one observation more on the feet of birds: I allude to the mechanism by which they are enabled to perch, even when sleeping, without using any muscular effort. This was first explained by the celebrated Borelli; and is effected by a tendon which passes over the heel, and is inserted into each toe. This tendon is so short, that when the leg is bent it necessarily draws the toes downwards, so as to make them grasp; and hence the mere weight of the bird makes the feet keep their hold. In sleeping, too, the head being placed under the wing, its weight is added; and thus the whole weight is brought to bear upon the legs.

LETTER XVI.

In my last letter I referred you to some examples of Divine wisdom displayed in the contrivances and arrangements which are followed in the economy of nature, for adapting animals to that mode of life which they have been allotted to pursue; and as I consider this a most useful kind of study, I will offer you one more example of a similar kind, in a noted inhabitant of the ocean — the whale.

Were our ideas of nature's productions not founded on strict and actual observation and research, we should, instead of possessing that satisfactory knowledge which every day is bringing to light, still wander in those mazes of error and conjecture which always characterise the infancy of science. How long, for instance, was the whale thought to be a fish? and by how many persons is it thought to be such even at the present time? Yet a fish it is not, any further than that it inhabits the water, and is of a fish-like shape. The true fish is cold-blooded, has a heart composed of only one ventricle and one auricle, breathes by gills, and does not suckle its young. The whale has the very opposite of all these characters: its blood is hot, like that of man, quadrupeds, and birds; it has, like them, a double heart of two ventricles and two auricles; like them it breathes the atmosphere by lungs; and like them, also, it suckles its offspring.

There are various kinds of whales; as the cacha-

lot, the broad-nosed whale, the white whale, the fin-fish, the grampus, porpoise, and several others. Some of them have formidable teeth, are very voracious, and great destroyers of fish and seals; while some are destitute of teeth, and prey only on animals of very small size. Such is the great Greenland or common whale (Balæna *mysticetus*), and to it I now intend to confine my remarks. This species grows to the length of seventy feet, and an individual sixty feet long will weigh seventy tons. It has, as I have said, no teeth; it has no arms for seizing its food; it cannot swallow any bulky object, for its œsophagus is barely wide enough to admit a man's arm. How, then, does it live? how is its vast bulk to be supported? The food of this enormous being consists of minute animals; as small medusæ, a small shell-fish called the northern argonaut (Argonauta *arctica*), which is less than the third of an inch in diameter; of some little crabs (Cancer *pedatus* and C. *oculatus*), and of some equally minute species of the genus Clio. According, however, to Mr. Scoresby's observations, a small kind of shrimp, about half an inch in length, which is semitransparent, and of a pale red colour, constitutes its chief food. In the stomach of a large whale he found these shrimps alone; but I should suppose that the food will vary according to the part of the ocean where the animal may feed; and hence, that as such part may abound in medusæ, or crabs, or shrimps, the nature of the whale's food will vary accordingly. Be this as it may, however, let us enquire how the huge animal contrives to capture a sufficiency of this minute prey.

Suppose, then, that you had a large quantity of sea-water containing the shrimps and other species alluded to, what would be the most effectual means which you could employ to separate them from it? Could you adopt any more efficient method than that of passing it through a filter? This plan would let the water run off, and leave them behind; and this is the contrivance which has been adopted in the whale; and what other would have answered the purpose I cannot conjecture. The filter is placed in the mouth, and is of a most perfect kind. With the substance of which it is composed you are well acquainted, though perhaps you have never thought of enquiring into its history. I speak of the elastic substance called whalebone, for it is of it that the filter is made. But before mentioning its structure let me remind you of the great size of the whale's mouth. Mr. Scoresby, whose intelligence and opportunities of observation make him the best of all authorities on this subject, says, that when open, "it presents a cavity as large as a room, and capable of containing a merchant ship's jolly-boat full of men, being six or eight feet wide, ten or twelve feet high (in front), and fifteen or sixteen feet long." *

The filter, then, is composed of above three hundred spars or blades of whalebone, or, as it is now more properly termed, of *baleen*, fixed in the gum of each side of the upper jaw, and making in all between six and seven hundred. These are all joined firmly by their upper edge to the palate, for

* Account of the Arctic Regions, vol. i. p. 455.

there are none attached to the lower jaw. Their broad ends are planted in the gum, and their narrow ends point to the upper part of the mouth. In a full-grown whale the central blades are fifteen feet long, but they gradually diminish towards the anterior and posterior ends of the cavity. Their greatest breadth is at the gum, and is there ten or twelve inches, and they are placed at such a distance from each other, that a hand could be slipped in edgewise between every pair. They resemble, Mr. Scoresby says, "a frame of saws in a saw-mill." The weight of these blades in a large whale amounts in all to a ton and a half; they form the framework as it were of the filter, but something more is necessary to complete it, for so far as we have gone, it would not answer the intended purpose. This, however, is accomplished in the most perfect manner, by the free edges of the laminæ being split into innumerable bristles, which make the whole ceiling of the mouth look like one continued brush or cushion of hairs. This, then, is the admirable organ by whose means the vast bulk of the whale is nourished, and here is another example of the Divine wisdom, combined with unlimited power, in which the so much neglected works of creation every where abound. Mr. Scoresby observes, that "when the whale feeds, it swims with considerable velocity below the surface of the sea, with its jaws widely extended. A stream of water consequently enters its capacious mouth, and along with it large quantities of water insects; the water escapes again at the sides, but the food is entangled and sifted, as it were, by the whalebone, which, from its compact

arrangement, and the thick internal covering of hair, does not allow a particle the size of the smallest grain to escape." * From a specimen of part of the filter of a young whale in my possession, I am led to believe that the hairs point obliquely upwards, to the median line of the palate, an arrangement which must add much to the certainty of retaining the prey; but there is one circumstance which I do not understand, namely, how it is separated from the filter, and brought to the gullet in order to be swallowed. The tongue can render little or no assistance; for it is tied down to the fat of the lower jaw, and is immovable. Perhaps from the direction of the stream, and the position of the hairs, the small animals are brought to the orifice of the gullet, and when accumulated to a certain extent, the whale shuts his mouth, lets the water drain off, and then swallows them, repeating the operation till his hunger is satisfied. You are aware that many flowers have their concavities lined with hairs, which point obliquely downwards, in such a manner that they effectually prevent the egress of any unlucky fly that may have crept into them. Some similar arrangement of the hairs in the whale's mouth would probably appear, on a proper investigation directed to ascertain this point.

The whale being furnished with this very curious instrument for taking his food, it is quite natural that we should next enquire, whether that food is sufficiently plentiful. It is a prevalent belief that heat is necessary to a profuse supply of animal and

* Account of the Arctic Regions, vol. i. p. 469.

vegetable life, and that it is owing to the greater warmth that there is such an abundance of both in tropical climates. Let us not, however, fall into an error here, and consider that as a *cause* which is only a *condition*. It is very true that there is a vastly greater variety of animals and vegetables in warm countries than in cold; but then we should consider the fact in this light, that God has made it a condition in the constitution of innumerable animals and plants that they shall require a certain temperature to carry on the functions of life, and that he has caused the largest number to require a high temperature. But it has been equally his pleasure, in the mighty scheme of creation, to form animals and plants whose constitution requires a low temperature, and to which heat is not only obnoxious, but the vicinity of ice and snow, or the exposure to a freezing temperature, is necessary to their very existence. We say that a palm is too tender to bear the cold of a northern country, but we might, with equal truth, assert that the Norwegian pine is too *delicate* to bear the heat of an equatorial sun. The snow-bird of Canada is killed even by the heat of a British spring; and "the polar bear," Mr. Fleming observes, "appears to be accommodated to live in a region, whose mean annual temperature is below the freezing point. In the summer temperature of Edinburgh, however well supplied with food, he appears to languish in misery. Cold spring water poured upon him seems to revive him for a little; but all relief is temporary — the climate is too hot for the enjoyment of life."*

* Philosophy of Zoology, vol. ii. p. 10.

To these there might be added almost innumerable other examples, to prove the absolute folly of supposing that all animals and plants were originally limited to one spot of earth. The creative power of God can be confined to no time and no space; the geological history of the globe shows that there have been various animal and vegetable creations long before man and the present living races of beings were called into existence; and in all countries there are various organised productions which can be found in no others. To imagine that the polar bear, or the rein-deer, have wandered from southern climates, in none of which they are to be found, and in which they could not live, is, to say the least, very childish. As well might we say that the tiger and the lion had wandered to Africa from Spitzbergen or Nova Zembla, or that the pine or the birch of Norway originally belonged to New Holland or the banks of the Niger. But how much more elevated ideas does it give us of the Almighty mind, to consider the wisdom with which it has appointed animals and plants to the particular circumstances of climate and food, for which their nature is adapted, than to suppose that they were left to wander at random from one spot over the rest of the earth. Is it not more consonant to reason, and is it not proved by fact, that the great masses of both the animated and vegetable worlds have been originally placed in their respective natural limits than to suppose that they inhabit these localities by a sort of chance?

Some plants are chained, as it were to a certain island, or rock, or mountain, and are found no-

where else; others, again, have a wider extent, and others wider still. Of the limitation to certain latitudes or districts we have ample proof, even in the British isles; for many plants grow in the southern counties of England, which are not found in the northern, and many inhabit the mountains of Scotland which grow in no other part of the United Kingdom. The red grouse, again, is found only in Great Britain and Ireland, but in no other part of the known world. Examples of this kind might be multiplied to a great extent, and at the same time not be confined to single species, for entire extensive families are unknown in some countries, though very abundant in others. Thus in the vicinity of the Cape of Good Hope there are above one hundred different species of heath, while in America no native heath has yet been discovered. The Thorn-apple, on the other hand, originally an American plant, has naturalised itself almost all over Europe; and some species, though naturally alpine, will, if removed from their native abodes, thrive in almost any situation; thus the Saxifraga *umbrosa*, which grows wild among mountain solitudes, far from the smoke and impure atmosphere of towns, agrees so well with the air of London, that it is commonly known by the name of "London Pride."

You thus see that all plants and animals have their particular constitutions; some have the greater part of the surface of the earth for their habitation, whilst others are limited to a very confined portion; some have been formed to exist on burning sands, and others on icy wastes: but in all their history

we plainly perceive the work and the wisdom of the Deity.

The vast magnitude of the whale shows that nutriment must be very abundant in those parts which it inhabits, and the fact is, that the seas and shores of the arctic regions swarm with animal life. Adelbert von Chamisso, the able naturalist of Kotzebue's first voyage, observes, in his remarks on Kamtschatka, that "as on the one hand in proportion as you go further in the land towards the north, the woods become less lofty, the vegetation gradually decreases, animals become scarcer, and, lastly, (as at Nova Zembla) the rein-deer and the *glires* vanish with the last plants, and only birds of prey prowl about the icy streams for their food; so, on the other hand, the sea becomes more and more peopled. The *Algæ*, (gigantic species of tang*,) form inundated woods round the rocky coasts, such as are not met with in the torrid zone. But the waters swarm with animal life, though all aquatic animals seem to remain in a lower scale than their relatives of the same class on land. The medusæ, zoophytes, mollusca, and crustacea, innumerable species of fish, in incredibly crowded shoals, the gigantic swimming mammalia, whales, physeters, dolphins, morse, and seals, fill the sea and its strand, and countless flights of water-fowls rock themselves on the bosom of the ocean, and in the twilight resemble floating islands."† But it is to Mr. Scoresby that we are indebted for our knowledge of the

* Sea weeds.

† Kotzebue's Voyage, Trans. vol. iii. p. 306.

source of this profusion of living beings. The Greenland sea had long before his time been observed to vary in colour, but the cause was not understood. It "varies from ultra marine blue to olive green, and from the most pure transparency to striking opacity."

The green water is in such quantity, that Mr. Scoresby supposes it to occupy one fourth of the surface of that sea between the parallels of seventy-four and eighty degrees. It is in it chiefly that the whale finds its food, and the fishers, consequently, are anxious to get into it. The green colour and opacity are caused by innumerable medusæ, about one twentieth or one thirtieth of an inch in diameter; they are found in less quantity in the bluish-green water, but in the olive-green they are innumerable. Mr. Scoresby calculated that a cubic fathom of it would contain twenty-three millions, eight hundred and eighty-seven thousand, eight hundred and seventy-two individuals; and a cubical mile 23,888,000,000,000,000. "From soundings made," he says, "in the situation where these animals were found, it is probable the sea is upwards of a mile in depth; but whether these substances occupy the whole depth is uncertain. Provided, however, the depth to which they extend be but two hundred and fifty fathoms, the above immense number of one species may occur in a space of two miles square. It may give a better conception of the amount of medusæ in this extent, if we calculate the length of time that would be requisite, with a certain number of persons, for counting this number. Allowing that one person could count

a million in seven days, which is barely possible, it would have required that eighty thousand persons should have started at the creation of the world, to complete the enumeration at the present time!"

"What a stupendous idea this fact gives of the immensity of creation, and of the bounty of Divine Providence, in furnishing such a profusion of life in a region so remote from the habitations of men! But if the number of animals, in a space of two miles square, be so great, what must be the amount requisite for the discolouration of the sea through an extent perhaps of twenty or thirty thousand square miles?" *

It is natural to enquire now what the end is that these interminable multitudes of living particles serve in the creation; and there can be little doubt that they are the source, minute though they be, of the pabulum on which depends the existence of the whale itself. These medusæ seem to be the food of the immense numbers of shrimps, minute crabs, cuttle-fishes, clios, and other marine animals, which are separated from the mass of waters by the filter already described; and thus, you will perceive, that even the whale depends for its own existence on that of so minute and gelatinous a point as this medusa. As the whale is of such enormous bulk, and as it has to come to the top of the water whenever it wants to draw breath, would we not, in reasoning on the subject, expect to find some provision by which it could with ease gain the surface? Most fishes have an air-bladder,

* Scoresby's Arctic Regions, vol. i. p. 179.

through whose means they increase or diminish their specific gravity, but no such bladder is found in the huge animal we are considering; and yet, notwithstanding its weight of seventy tons, it is light enough to float without effort, and when dead it lies like a log upon the surface.

This buoyancy arises from the great quantity of fat or blubber, which forms a layer every where under the skin, of a thickness varying in different parts from eight to twenty inches. The lips are almost entirely of blubber, and afford from one to two tons of oil each; and so immense is the quantity of this substance altogether, that in a grown whale it amounts to thirty tons.

But besides giving buoyancy, it serves another very important office. You know that warm-blooded animals are constantly generating heat, and that this is necessary to their existence; now suppose that on a frosty day you wear a pair of *hard-knit* woollen gloves, and suppose also, that you make trial, in a similar temperature, of a pair made of soft spongy flannel, which would be only half the weight of the former, I think you would find these the warmer, notwithstanding their less quantity of substance, and the reason is this: some bodies conduct, or in other words, carry off heat much more powerfully or rapidly than others. If you grasp a bolt of iron in your hand in freezing weather, you will find it intolerably cold, while a walking stick of equal thickness, held in the same way, would cause no uneasiness. But the wood is not therefore in reality warmer than the iron, and the difference between the two is, that heat cannot

travel nearly so fast through the wood as through the other material. Cold, you must recollect, is not a positive but a negative quality, it is merely the *absence of heat.* When, therefore, you touch the iron, it feels very cold because it is a good conductor of heat, and the latter leaves your hand and penetrates it. The iron, therefore, feels colder than the wood, not because it is actually colder itself, but because it draws a larger quantity of heat out of your hand; and in consequence of your hand having lost this, the sensation of coldness is produced. Wool is itself a bad conductor of heat, and this is the reason why it forms a warm covering; it carries the animal heat off very slowly. Much of its utility, however, in this respect, depends on the mode in which it is manufactured; if it be wrought, as in the *knit* gloves, into a dense close texture, it will be a much better conductor than when its fabrication is loose, soft, and spongy, and, consequently, will not form so good a protection from cold. The reason is this: air is considered, *when at rest,* as perhaps the very worst conductor of heat that is; and it is owing to this non-conducting power that new or spongy flannel is so warm an evelope, the air contained in its interstices being in considerable quantity, and by its non-conducting quality preventing the heat of the body from being dissipated.

"But," you will say, "what has all this to do with the whale?" Why this, that the coat of blubber serves the same purpose to it that a woollen covering does to yourself, or what is, perhaps, more immediately to the purpose, that the natural coat

of wool does to the sheep. The whale is warm-blooded, it inhabits the cold medium of the water in the frozen seas of the arctic circle; fat is a bad conductor of heat; and by being so thickly enveloped by it, and its blood being at the same time warmer than that of man and quadrupeds, the whale is enabled to exist unmolested by the frigidity of its place of abode. We find still farther, that the *nature* of this fat affords us an instance of wise design; it is very fluid, so that it cannot congeal by exposure to cold, as might happen had it been equally consistent with that of the sheep or ox. Hence, when separated by heat from the tissue which holds it, instead of concreting like rendered lard, or tallow, or suet, it continues in the state of oil (it is the train oil of commerce); and the same wise provision extends to the other whales, the seals, and the walrus or sea-horse, all warm-blooded animals, which live or seek their food in the same cold element.

The blubber or fat of the whale being thus wisely appointed, first, for buoyancy, and, next, as a protection from the cold, must, after all, we might conceive, prove an incumbrance to a considerable degree. Even to a whale the carrying about with it thirty tons' weight of passive material might be supposed inconvenient; but it is *not* so; the immense muscular power of the tail renders the animal capable of such activity, that when occasion requires, it can swim for some time at the rate of nine miles an hour, and about half that velocity in its usual measure of progression. It can, on ascending from the depths of the sea, spring entirely

out of the water; and this it appears to do often as an amusement. Besides this movement, "whales sometimes," Mr. Scoresby observes, "throw themselves into a perpendicular posture, with their heads downward; and rearing their tails on high in the air, beat the water with awful violence. In both these cases the sea is thrown into foam, and the air filled with vapours: the noise in calm weather is heard to a great distance; and the concentric waves produced by the concussions on the water, are communicated abroad to a considerable extent. Sometimes the whale shakes its tremendous tail in the air, which, cracking like a whip, resounds to the distance of two or three miles." * One circumstance respecting the tail you will keep in mind, which is, that it is horizontal instead of being vertical, like the tail of a fish, and this formation enables the animal to ascend and descend with a facility which a perpendicular position would not. I must again quote Mr. Scoresby. "The tail," he says, "comprising in a single surface eighty or one hundred square feet, is a formidable instrument of motion and defence. Its length is only five or six feet, but its width is eighteen to twenty-four or twenty-six feet. Its position is horizontal. In its form it is flat and semi-lunar, indented in the middle, the two lobes somewhat pointed and turned a little backward. Its motions are rapid, and universal; its strength immense." †

I have mentioned that the substance called *whalebone* in commerce, is improperly so named. It is

* Arctic Regions, vol. i. p. 467. † Ibid. p. 455.

a modification of horn; but the real bones of the whale are of great size, though their specific gravity is comparatively small: they are spongy or porous in their structure; for it is an object of great importance that they should not be heavier than is absolutely necessary for their required strength; and here again we meet with consummate wisdom, exerting consummate power to accomplish an intended end. This leads me to throw out a few hints respecting the origin of the bony skeleton in general, and of the other substances of which you yourself, in common with most of the individuals of the animal kingdom, are composed.

The animal body consists in a great measure of fluids, and in its earliest stage is fluid altogether. It is known that the bodies of men and animals which have perished in the sandy deserts of Arabia, are sometimes found so dried up, as to be almost as light as a sponge; and an entire mummy of one of the Guanches, or original inhabitants of the Canary islands, which Sir Joseph Banks sent to Blumenbach for his museum, weighed only seven pounds and a half, though all the muscles and viscera were preserved *; from which, along with other observations, we learn that the great bulk of the animal frame consists of water alone.

Chemistry has taught us that animals, in common with vegetables, are formed of carbon, or charcoal; of hydrogen, or inflammable air; of oxygen, or pure air; and of nitrogen; which last composes the bulk of the atmosphere, and the great predominance of

* Blumenbach's Physiology.

which in the animal composition forms the chief distinction between it and that of vegetables. Besides these, which compose the basis of organised bodies, there are various other substances, as phosphorus, sulphur, iron, potash, silica, lime, &c. in minute portions. The lime which forms the skeleton is infinitely more abundant in animals than any other ingredient of the mineral kingdom; but even that is generated, I believe, in the animal laboratory from its simple elements, whatever these may be: for though it is very probable that the portion of lime which is contained, in some degree, in most kinds of food, may be applied to the formation of bone, yet it is certain that when the food of animals is destitute of cretaceous matter, their bones are not the less perfect and solid. "A healthy animal of any kind," the late Dr. Good observes in his immortal work, the Study of Medicine, "appears to supply itself with the requisite quantity of bony earth, whatever be the nature of its food, and though the soil on which it is grown contains no lime whatever, as is the case in several of the Polynesian islands, and throughout the whole of New South Wales, on the hither side of the Blue Mountains." *

The form, moreover, in which lime exists in the bones, is one that rarely occurs in the mineral kingdom. It is a salt composed of lime, combined with the phosphoric acid; and that this acid is a product of living organisation appears pretty certain. It is contained in many vegetable substances, sometimes

* Vol. v. p. 356. ed. 3.

free, though mostly in combination with lime or potash; but in all these it is in too minute a proportion to be at all adequate to supply the quantities which exist in animals; and there is every probability that both the acid and the lime are formed by the vital chemistry of the animal organisation. If this be true, we may readily perceive one important advantage arising from it, which is, that it prevents animals from being left to the fortune of chance to determine whether their bones shall be solid or not. These, like other parts of the body, are in a constant state of change, the old particles being perpetually removed, and as regularly replaced by particles that are new.

Suppose, then, that an animal has its food changed to one which contains no lime, or that it is removed from a calcareous soil to one where no trace of that earth exists, what ought the consequence to be, if it were requisite that it should be supplied ready formed in the food? The consequence would be this: the animal would soon have no bones at all. The old particles would continue as usual to be removed, but the supply of new ones being cut off, the skeleton would lose its solidity, and assume the state of cartilage or gristle. This is a morbid change, indeed, which sometimes does take place, forming the disease called mollities ossium, in which the bones are as soft as wax; but this does not arise from any defect of lime in the food, nor does the administration of chalk, or of that earth in any other form, tend to arrest the progress of the disease. Again, as the bones of men and animals living in places destitute of lime are not deficient in calca-

reous matter, so we find that those inhabiting chalk or limestone districts are not in any way remarkable for the hardness, size, or strength of their bones above what occurs where no lime is found. A careful analysis to ascertain the whole quantity of both of these in a chicken newly hatched by artificial heat, would probably throw considerable light on this subject, which is still involved in much obscurity.

LETTER XVII.

If the ocean, in many of its aspects, be beautiful, it is in others sublime, or awful, or terrific. When the waves are dashing high up the dark rocks, and the storm is brewing in the northern sky, few objects in nature are possessed of a greater degree of sublimity; and when the whole force of the tempest comes to bear upon the agitated mass, when the dense clouds are rent by the lightning, and the thunder lends its voice to complete the perturbation of the scene, a degree of breathless awe is felt by most persons who behold this wild commotion and strife of the elements.

"Let any one," says Mr. Macgillivray*, "who wishes to have some conception of the sublime, station himself upon a headland of the west coast of Harris, during the violence of a winter tempest, and he will obtain it. The blast howls among the grim and desolate rocks around him. Black clouds are seen advancing from the west in fearful masses, pouring forth torrents of rain and hail. A sudden flash illuminates the gloom, and is followed by the deafening roar of the thunder, which gradually becomes fainter, until the roar of the waves upon the shore prevails over it. Meantime, far as the

* See his excellent account of the Outer Hebrides, in the Edinburgh Journal of Natural and Geographical Science, vol. i. p. 249.

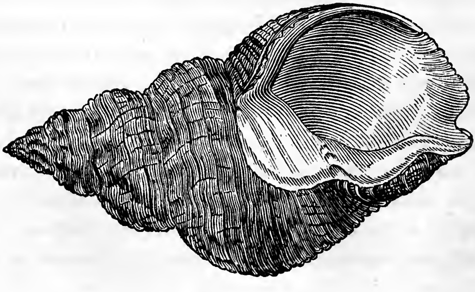
eye can reach, the ocean boils and heaves, presenting one wide-extended field of foam, the spray from the summits of the billows sweeping along its surface like drifted snow. No sign of life is to be seen, save when a gull, labouring hard to bear itself up against the blast, hovers over head, or shoots athwart the gloom like a meteor. Long ranges of giant waves rush in succession towards the shores. The thunder of the shock echoes among the crevices and caves; the spray mounts along the face of the cliffs to an astonishing height; the rocks shake to their summit; and the baffled wave rolls back to meet its advancing successor. If one at this season ventures by some slippery path to peep into the haunts of the cormorant and rock pigeon, he finds them huddled together in melancholy silence. For whole days and nights they are sometimes doomed to feel the gnawings of hunger, unable to make way against the storm; and often during the winter they can only make a short daily excursion in quest of a precarious morsel of food. In the mean time, the natives are snugly seated around their blazing peat-fires, amusing themselves with the tales and songs of other years, and enjoying the domestic harmony which no people can enjoy with less interruption than the Hebridean Celts."

One effect of such tempests as these here described is to dash to pieces the animals and plants that have been loosened from their hold, and carried to the shore. But after a moderate storm, especially on a broad sandy coast, there are often found great numbers of shells, corallines, crustaceous animals, sponges, and sea-weeds, with other produc-

tions of the deep; and the naturalist, on visiting the shore after these heavy gales, is seldom disappointed in finding a rich harvest.

And here comes the great utility of systems and classifications. It is by them that the student gains an accurate knowledge of these objects; and nothing has ever served to give clear conceptions of the differences between individual animals and plants equal to what they have done. Classification forms the most useful guide by which the student can arrive at an acquaintance with the myriad links which compose the great chain of animal or of vegetable life; and it gives an accuracy and exactness of notion respecting them which is not, perhaps, otherwise attainable. Even the mere circumstance of knowing the scientific name of an object may prove of the first service in leading us to a knowledge of all that is known respecting it. Suppose, for example, that you pick up the shell represented in *fig.* 21., and which you have not seen before,

Fig. 21.



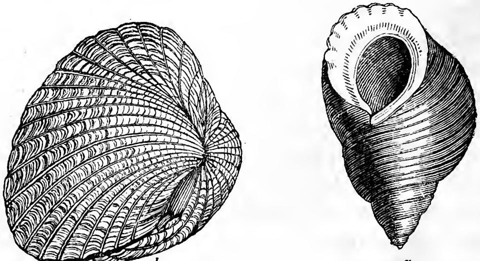
how are you to ascertain what it is? On asking the first person you meet, he will, perhaps, say, "O, that is a Buckie;" you apply to a second, who tells you that it is a Conch; and from a third you learn that it is a Whelk. But even suppose that they all give it the same name, still you are not much the wiser, for scarcely in any two counties do the same things go by the same name. Your object, on the contrary, is to find an appellation for it by which you can trace out all that is known about it, either in your own or in other languages, and by using which you could distinctly make apparent to other naturalists the *exact* species you intend, even though these naturalists should reside in countries the most distant from your own. The shell in question is the Buccinum *undatum* of Linnæus; and knowing this, if you have access to works on conchology, you can find out its history so far as authors are acquainted with it.

I shall now make some remarks on the study of shells, which may, perhaps, be of some use to you, though they must be considered as only a few hints respecting a very extensive department of science, which, from its relation to geology, as well as from its own intrinsic beauty and elegance, is rising every day into higher estimation and importance. In order to investigate fully any part of natural history, you must acquire the introductory and technical knowledge, and terms attached to it: or, perhaps, the most useful of all methods of commencing a study such as this, is to learn the ordinary and scientific names of some common specimens, and

compare them, and their different parts, with the description given of them in some good and standard work on the subject; and having gotten an accurate acquaintance with these species, to go on to others, and study them in the same manner. I shall now attempt to lead you on, for some way, by this method; and if you have not yet turned your attention to the scientific pursuit of natural objects, I may perhaps lend you some assistance. Of all classifications, either of animals or plants, I consider that of Linnæus to be the most peculiarly fitted for the *student*, both on account of its simplicity and its practical usefulness. I will, therefore, take his arrangement of the Testacea as my guide.

Well, then, here (*fig.* 22.) are two British shells,

Fig. 5.

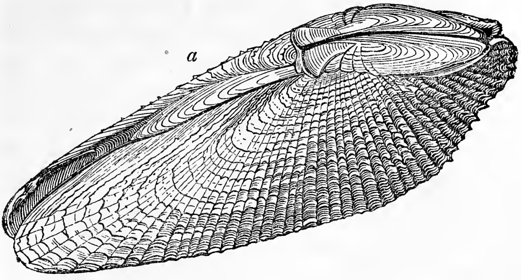


b *a*

both of them very common. The one (*a*) is the common periwinkle, Turbo *littoreus* of Linnæus; and the other (*b*) is the common or edible cockle,

Cardium *edule*. *Fig.* 23. represents the prickly

Fig. 23.



piddock, or the prickly piercer, or pierce-stone, Pholas *dactylus*. Now, these are examples of the three great divisions into which shells are arranged, of univalves, bivalves, and multivalves; a division sufficiently natural, and which was first adopted, I believe, by the great Aristotle. But what is meant by a valve? In conchology it means simply a piece. The periwinkle, therefore, being formed of only one piece, is a univalve; the cockle, being of two, is a bivalve; and you observe, that in the piddock, besides the two large or primary pieces analogous to the valves of the cockle, there are also the additional portions (*a a*); and, therefore, this shell, being composed of more than two pieces, is a multivalve.

Which, then, of these three shall we attend to first? For our present purpose this would be of no consequence whatever; but I may mention to you, that Linnæus, in his great work, the Systema

Naturæ, arranged the TESTACEA in the series of multivalves, bivalves, and univalves; but some modern writers have preferred treating of the univalves first, and the multivalves last, under the idea, that as the former are simpler in construction, it is more natural to place them foremost. This very simplicity, however, of the univalves forms a great source of difficulty in understanding them; for the several genera run by such faint shades into each other as to require a very experienced eye to discriminate them. The genera of the multivalves, on the contrary, are so strongly marked as to be easily distinguished from each other, while, at the same time, their number is comparatively inconsiderable. On these accounts, the arrangement of Linnæus is decidedly, I think, best for those commencing the study of conchology.

According to this plan, you will therefore first examine into what can be learned of the Pholas; but, for this purpose, you must have books, or access to books, where a knowledge of it is to be found. Suppose you select Burrow's Elements of Conchology *; Turton's Conchological Dictionary †; and Dillwyn's Descriptive Catalogue of Recent Shells. ‡ You find, on looking into the first, that the multivalves consist of only three genera, Chiton, canoe or boat-shell; Lepas, or barnacle-shell; and Pholas, dactyle, pierce-stone, or piddock. You learn

* One vol. 8vo. with 28 plates. London. Duncan, Paternoster-Row.

† One vol. 12mo. 28 plates. London. Booth, Duke-Street, Portland-Place.

‡ Two vols. 8vo. London. Arch, Cornhill.

from it also, that the Pholades have their name from the Greek word φωλέω (pholeo), to seek a hiding-place, because, when young, they pierce into stones and wood, and there remain, the cavity in which they lodge increasing with their growth; that the finest specimens are oftenest found in chalk; that it is not understood how they can bore into such hard substances, but that, probably, it may be by the means of some chemical agent, secretion, or menstruum, which acts on limestone and wood. "It appears, indeed," the author observes, "scarcely possible that these mollusca should be able to obey the instinct of their nature without some aid from a softening or dissolving fluid. They are, doubtless, deposited as soon as formed, in the superficial cavities of the rock or wood; for they are usually discovered in great numbers about the same place, as if from the ovary of a common parent." * The animal emits a phosphorescent secretion, which, he also conjectures, may be the menstruum alluded to. To this I shall, however, recur again; and the species with which we are now engaged being a British one, we shall compare it with the description given by the very accurate Turton, and unravel or ascertain the meaning of terms and phrases as we proceed. I am taking it for granted, let it be observed, that you are unacquainted with the scientific pursuit of any branch of natural history; and, therefore, my remarks may be very useful to you, though unnecessary altogether to a more advanced student.

* Burrow's Elements, p. 46.

Turning, then, in alphabetical order to the word Pholas in the dictionary mentioned, we find the following definition of the genus : —

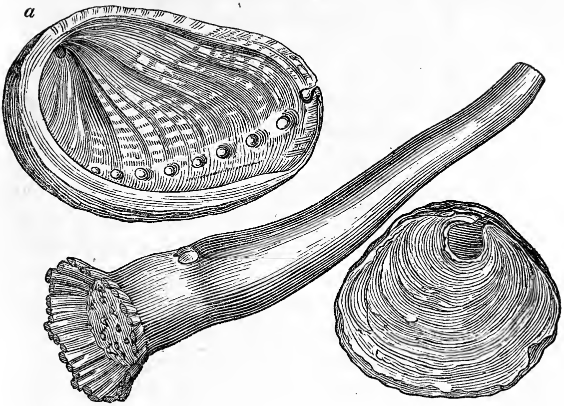
" Shell with two large primary valves, open at both ends, and several lesser ones about the hinge: teeth long, incurved, one in each valve on the inside."

Now, should you find any shell possessed of those characters, you know at once that it is a Pholas, though you may never have seen it before : and this is one great step gained ; for having ascertained the genus, you next proceed to find out the species, that is to say, the identical shell you are examining. But let us now look into the exact meaning of the words of the above definition. By the large valves being open at both ends, we are not to understand that there are holes in them; but that they do not close so as completely to shut up the animal. The opposite of this you observe in the cockle, which is closed all round. I may observe, however, though perhaps a little out of place, that there are various species whose shells *are* perforated, as, for example, those belonging to the Haliotis genus (*fig.* 24. *a*), and most of the anomia tribe (*b*). The shell called the watering-pot (serpula aquaria), found at Java, Coromandel, and various other parts, is a very curious example of a perforated shell, it having its summit bored like the rose of the stroop of a garden watering-pan (*fig.* 24. *c*).

The next thing mentioned is the Hinge; and this is a very important part, especially in the study of the Bivalves, as the genera of these are

Fig. 24.

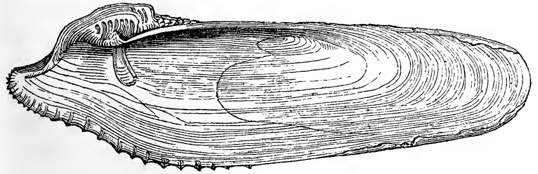
a



c b

mostly constructed upon it. It consists of two parts, the cartilage and the teeth, which latter I shall advert to when we examine the cockle; and in the mean time the following figure (*fig.* 25.) will

Fig. 25.



give you a notion of the incurved tooth of the Pholas. The first species mentioned, as we proceed with Turton, is the one I am now speaking of; and hence the description goes on thus:—

"1. Pholas Dactylus. *Prickly piddock.*" And then comes the following list of references: —

Lister, pl. 433. f. 276., and App. pl. 19. f. 1, 2. *Pennant*, pl. 42. f. 1. *Da Costa*, pl. 16. f. 2. *Donovan*, pl. 118. *Wood*, pl. 13. f. 1, 2, 3. *Dorset Cat*. pl. 3. f. 2.

These are references to the works of British authors in which this shell is represented by a figure. The first reference is to the great work of Dr. Martin Lister, entitled "*Historia, sive Synopsis Methodica, Conchyliorum*," in the 433d plate of which the figure marked 276. is the present shell, and also figures 1. and 2. of the 19th plate of another work of the same author, entitled "*Appendix Historiæ Animalium Angliæ*." In each of the books we have selected, you will find lists of authors who have written on Conchology; and, therefore, when you meet with a reference which you do not clearly understand, turn to these lists, and you will there ascertain the name of the author, the title of his works, the place and year when published, &c. In Turton's Dictionary the account is limited to British authors; but in Burrow's Elements and Dillwyn's Catalogue you will find an alphabetical arrangement of the writers on conchological science, whether British or foreign. Dr. Turton gives some account also of the works mentioned by him, and some occasional observations respecting their authors. For instance, you wish to have some idea of the work of Lister, first referred to above; you therefore look for the word "Lister" in Burrow's List of Writers on Conchology, and you find the following: —

"Lister, Martin. Historia, sive Synopsis Methodica, Conchyliorum. Lond. 1685—1692. Oxon. 1770, à Gulielmo Huddesford, with copper-plates."

But in Dr. Turton's work you find the following interesting remarks on this same work: —

"*Lister*. Huddesford's edition, Lister's Historia Conchyliorum. Folio, 1770. The basis and ancient foundation of all good Conchology. This admirable volume contains one thousand and fifty-five plates, besides twenty-one of anatomical figures; all drawn from original specimens, by his two daughters, Susanna and Anna. Considering the state of natural science at the time this work was first issued, one hundred and thirty-three years since, it is impossible to contemplate this stupendous effort of genius and industry, without admiration at the grandeur of the design, and the correctness of its execution. Some of the plates, especially the anatomical ones, are of matchless excellence. And it is gratifying to recollect, that the original drawings are preserved among the archives of the University of Oxford. His Historia Animalium Angliæ, and its Appendix, are now of rare occurrence."

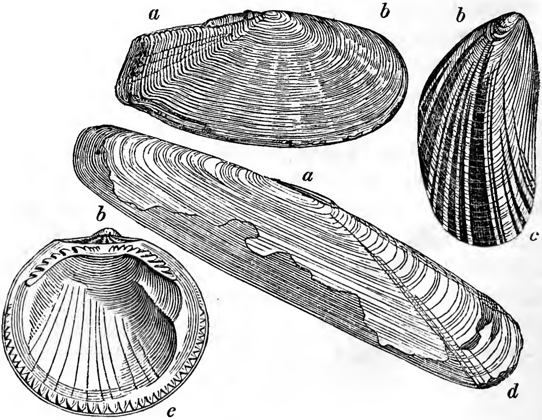
If you examine the account of this species in Dillwyn, you will find a much longer list of references, these not being there limited to British writers. And though at first you may have some little difficulty in understanding them, yet by a little practice in examining the lists of authors I have alluded to, you will soon get acquainted with these abbreviations, and know to what books they relate.

The description of the Piddock given by Turton

is too long for my present purpose; and, therefore, I will adopt Dillwyn's. In page 35. of his work, you will find this specific character: — "Shell oblong, with reticulated striæ; and the *anterior end* strongly muricated and beaked."

And, as is usual in systematic arrangements, there is, after the references and synonymes, a further description, thus: — "Shell *about an inch and a quarter long, and four or five inches broad*, thin, brittle, and white; the exterior surface is covered with reticulated striæ, which gradually become stronger and more prickly towards the *anterior end.*" I have marked with italics the terms which I think you will here require to be explained. What is the anterior end of a bivalve shell (for the Pholas, with the exception of the accessory valves, is in all other respects a bivalve)? *Fig.* 26. will explain. The part marked *a* is a tough elastic horny substance,

Fig. 26.



which connects the two valves on one side of the summits or bosses (umbones) of the shell (*b*), and is named the Ligament or Cartilage. This is so constituted, that, by its elasticity, the valves have a constant tendency to open. They are kept shut by the contraction of a muscle inside; and hence, when, in opening an oyster or a scallop, we cut through that muscles the shells separate to a considerable distance. When the animal also is so long out of its native element, that it is thereby greatly weakened, and the contractile power of the muscle diminished, we observe that the animal lies with the shells open, the elasticity of the ligament being too powerful for the debilitated contractility of the muscle. Now, the part where the cartilage or ligament is placed is the *anterior;* while, of course, the other side is the posterior end.

You may next, perhaps, think it rather singular that the shell should be described as so much broader than it is long; but you must learn, that the length of a shell means the distance from the hinge to the base; and, consequently, the length may either be the longer or the shorter diameter, according to the species. The muscle, for example, (*fig.* 26. *c*) is as long again as it is broad; while in the pod razor shell (Solen *Legumen*) (*fig.* 26. *d*) the breadth is nearly four inches, and the length scarcely three quarters of an inch. The length of a shell, then, does not mean its longest diameter, but the space from the hinge to the base; and, consequently, it varies exceedingly; in some shells being longer, in some much shorter, and in others

neither longer nor shorter than the breadth, as in some species of Arca. (*fig.* 26. *e.*)

There are six British species of Pholas, and about a dozen or fourteen known altogether: Dillwyn describes eleven. You will recollect that in them all, the accessory valves are very deciduous, that is, they readily fall off: they are also easily broken; and hence, in specimens not well preserved, they are often wanting; but still, by the single incurved tooth in each valve, together with the general aspect, you will readily recognise them, so far, at least, as the genus is concerned. Some species of Pholas are used as food, and also by fishermen as a bait. But the most remarkable fact in the history of the Pholades, is the power which they have of lodging in rocks and wood, even the hardest oak. This property, however, is not confined to them, for there are other species of testacea which form similar lodgements, in a manner equally inscrutable; such are several of the Mya genus, the Donax *Irus*, or foliated wedge-shell, some Venus shells, the burrowing, cross-beaked, coral-piercing, and other muscles, besides some more bivalves; but I am not aware that any of the univalves have a similar property. These animals have no mechanical instruments for boring, and much conjecture has been used relative to the mode by which they can accomplish so apparently arduous and difficult a task as forming their cells. Most, if not all of them, secrete a luminous fluid; and I believe the most general opinion is, that this luminosity is connected with or caused by phosphorus. Dr. Turton

observes, that the three species of Pholas (*dactylus*, our present one; *parva*, or small piddock; and *candida*, or white piddock,) are found in vast numbers in masses of rock, taken at the mouth of the river just below the town of Teignmouth, in Devonshire; and he remarks, that "the philosophy of their natural history may probably be of no very difficult solution. The rock in which they are embedded is a cementation of the finest sand and lime, and of so very soft a substance when first taken from its bed, as to be easily cut with a knife into any form, and sufficiently absorbent to afford moisture for the purposes of life and their peculiar action. The animals themselves abundantly secrete a mild phosphoric solution, as may be seen by its illuminating in the dark whatever is moistened with it, sufficiently powerful to decompose the rock by the slow contact of their gradually increasing bulk. The atmospheric air also seems to be occasionally necessary to this process, as they are always found in situations which are left dry for a short period by the recess of the lowest tides, its oxygen perhaps serving by its union with this secretion to form a phosphorous acid. In confirmation of this belief, we have affixed them, when fresh taken, to a smooth piece of the same rock, by the frontal gape, occasionally moistening them with sea-water; and in a few days have found, that at the place of contact an evident waste of substance had been made by the decomposition of the lime and a deposition of sand in the finest grains. It may reasonably be supposed that all the borers of rock and wood, even the teredo, act in

this manner by their peculiar and appropriate solvents."*

I am afraid that this throws very little light on the subject. We have no proof that the luminous secretion of these animals is owing to phosphorus; and we know that many species which have the luminous are quite destitute of the burrowing property; and, besides, the phosphoric acid would be about the worst agent which could be selected, because the phosphate of lime is *insoluble in water*, and I should fear, that when the carbonate was decomposed, the phosphate produced, instead of being carried off, would be deposited, and form a more intractable substance than the original chalk. May it not be possible that the animal has a power of decomposing the sea-salt as its wants may require, and applying the liberated muriatic acid to the solution of the calcareous rock? The muriate of lime is particularly soluble in water; so much so, indeed, that it forms a deliquescent salt, and therefore it would be carried off as fast as it could be formed. This, however, is mere conjecture; but the subject is worthy of regular investigation by observation and experiment. I do not recollect that any *freshwater* shell-fish have the same burrowing quality unconnected with mechanical operation; a circumstance which, if correct, might throw some probability on the supposition of the muriate of soda becoming decomposed by the sea animals.

I have long had a suspicion that there is a specific dissolving agent, different from any acid or alkali,

* Conch. Dict. p. 145.

and which betrays itself in various circumstances, and always in connection with organisation. Miss Hutchins made the curious discovery that two sea plants, the Fucus *viridis*, pinnated green fucus, and the Fucus *ligulatus*, green strap-leaved fucus, have the property of dissolving other sea-weeds with which they come in contact, though they themselves remain unaffected. Does not this bear a strong analogy to the action of the gastric juice? Experiments might throw much light on the question; and perhaps the first in the series would be to ascertain whether these plants, like the gastric juice, will rennet milk. What is the agent by which the fungi producing the dry-rot operate? Why will the Byssus *septica* of Linnæus destroy in a short time the hardest oaken cask, whereas did not such plant attack it no decay would take place? How does the Lichen *immersus* bury itself in the surface of limestone rocks? I can answer none of these questions; but the facts seem to bear strongly in favour of my conjecture, that there does exist in nature some peculiar dissolving or corroding agent, not yet discovered, but which betrays itself by a variety of phenomena in the animal and vegetable kingdoms.

That the Pholades and other shell-fish do not effect an entrance into wood and stone by means of the luminous secretion, is evident, I think, from the circumstance that the secretion seems to be always going on, and therefore would be perpetually effecting the chemical decomposition of the stone; whereas the extent of the excavation seems to be regulated by the animal, and is only so wide as to

allow the latter to turn round within it. The surface of the habitation, too, instead of being rough and irregular, as it would be if formed by an acid let loose at random, and not applied by some operating instrument, is smooth, perfectly circular, and its bottom concave, like a cup formed with the nicest art. The shell of the Pholas is very thin and light, which some might imagine as arising from its being acted on by acid as well as the rock; and, indeed, had the luminous secretion the dissolving power attributed to it, there would be some difficulty in conceiving how the animal could have a shell at all. But the thinness of these shells is not accidental. In their situation thick shells would be useless at least, if not an incumbrance, to the animals; and this remark leads me to observe to you, that we often find the thickness and strength of shells to vary according to the place which they naturally inhabit. Take the pearl gaper (Mya *margaritifera,*) and the swan muscle (Mytilus *cygneus*), as examples of this. They are both bivalves, which inhabit the fresh waters of our native country; but the shell of the former is many times thicker and more ponderous than that of the latter. The gaper inhabits *rapid rivers;* the muscle, deep ponds, lakes, and canals. Were it not for the weight of the shell in the former, it would be too easily swept down by floods; and were its shell not thick, it would be broken by collision against stones. On the other hand, the swan muscle is not liable to these casualties, and a heavy shell, while it would be useless, would be an incumbrance to it. We observe, again, that the shell-fish which inhabit

stony shores, and do not bury themselves in sand, as the cockle, or have not a mooring apparatus, as the common or edible muscle, possess very thick shells. Such are the periwinkle (Turbo *littoreus*), and the dog-whelk (Buccinum *lapillus*), *fig*. 27.

Fig. 27.

The Buccinum *Lapillus*, or Dog-Whelk.

The purple ocean, or blue snail-shell (Helix *janthina*), again, is a wanderer of the deep, and never designedly approaches the shore. It therefore requires rather a light and portable than a strong and heavy house, and accordingly we observe that this even equals in thinness the shells of land snails. It is often found in great numbers floating together, many hundred miles distant from land; and the method it uses to remain at the surface, or descend below it, is not a little curious. It is said to have the power of forming at pleasure a little vesicle of tough mucus, inflated with air, by which it floats; and when the object is to descend, this bubble is cast off, and the animal sinks. Some voyagers describe this vesicle as permanent; and if so, it must be composed of an organised membrane. The purple ocean-shell has been repeatedly found on

the Irish and English coasts; but in such instances we are to consider it merely as a stranger, which has been thrown accidentally upon our shores. The animal is plentifully supplied with a purple juice, which is luminous in the dark; but many medusæ, and other marine animals which have not a shell, are luminous: the Pyrosoma *atlanticum* is intensely so.

To return to our subject, I must again observe, that we are as yet ignorant of the mode by which the piercing shell-fishes bore into stone and wood. The animals, agreeably to all analogy, are very small when they commence their operations; and I believe we shall always find that the aperture of the hole is narrower than the interior. At the same time it is obvious that the whole cavity is enlarged as the animal grows; for we always see that, the wider it is within, the wider also is the entrance. Some have supposed that the shells act mechanically like rasps, in wearing away the stone; but that notion is confuted—first, by the reticulations and prickles on their surface being regularly perfect; and, secondly, by the circumstance of the stone into which they penetrate being often of a hardness vastly superior to their own. It has been supposed that these borers are useful to mankind, by eating away, and thus destroying, the trunks of trees, which, being brought down by rivers, serve to choke up the entrance from the sea. This opinion, however, is perhaps too far-fetched; and we see no provision made for destroying the snags which produce so many accidents and obstructions in the navigation of many of the great American rivers.

LETTER XVIII.

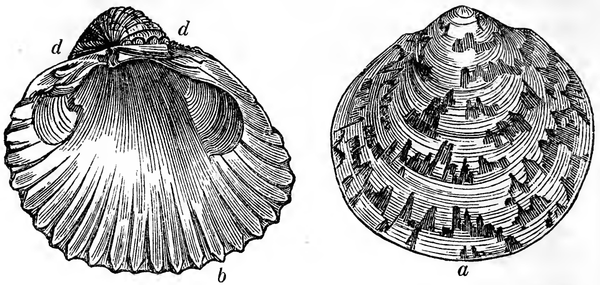
We shall now consider the cockle (Cardium), of which Dillwyn gives the following generic definition: —

"Shell bivalve, nearly equilateral, and the valves equal; hinge with two primary teeth alternating with those opposite, and the lateral teeth remote and inserted."

He describes forty-six different species, of which nine are British. Our specimen is the Cardium *edule*, and is characterised thus: — "Shell antiquated, with twenty-six longitudinal ribs, and transversely wrinkled somewhat imbricated striæ."

This is truly a bivalve shell, as it consists of two parts only, and has no accessory pieces or valves like the Pholas. In the definition of the genus, you observe that the shell is "nearly *equilateral*, and the valves *equal*." Now, what is the difference of meaning in these two expressions? One would suppose them to be synonymous. We have before seen what is meant by the anterior and posterior ends of a bivalve; now, end and side mean here just the same thing: and, therefore, when these are equal in dimensions, and similar to each other, the shell is equilateral, or equal-sided; as, for example, in the downy ark shell (Arca *pilosa*, *fig.* 28. *a*), in which you observe, that if it were cut down longitudinally into two halves, the one half would be nearly an exact counterpart of the other. In the

Fig. 28.



Pholas, on the contrary, a similar section would show that the two sides or ends are very dissimilar, and, therefore, the Pholas is inequilateral; while in the cockle you perceive that the shell is "nearly equilateral." (*fig.* 28. *b.*)

But the term "*equivalve*" does not apply to the ends or sides, but to the entire valve, whether the *sides* be equal or not; and it means, simply, that the two valves of a shell are in all respects like each other. *Equilateral*, then, means, that the two sides are equal and alike; *equivalve*, that the two valves, in their whole dimensions, are similar in all respects to each other. Inequilateral and inequivalve are the opposite terms.

"Hinge with two primary teeth." These are also called *cardinal* teeth. In *fig.* 28. (*b*), which represents one valve of the cockle, you observe two teeth placed near each other (*c*), and two others at a considerable distance (*d d*). The first are the primary, the second the lateral teeth. The rising part of the shell at *c* is the umbo, or boss; and the

sharp point of this is named the apex, or beak. Now, the cardinal or primary teeth are such as are placed between the beaks. The meaning of the lateral teeth being inserted is, that they are received into corresponding hollows or pits in the opposite valve, when the shell is closed.

In the specific definition the cockle is said to be antiquated; a term thus explained in Burrow's Elements: — "Longitudinally sulcate, or furrowed, but interrupted by transverse accretions, as if lesser valves were periodically added to the apex, or beak." The word imbricated means tiled, or one thing placed over another like tiles on a roof. This imbricated appearance of the striæ in the cockle is chiefly observable in old shells. You have now another example of the method you should adopt in studying Conchology, or, indeed, any other branch of natural history. Commence with such subjects as you are already acquainted with, and compare them with the descriptions given in systematic and introductory works; and thus you will, by degrees, get familiarised with technical terms, and the proper mode of investigating objects, so that at length you will be enabled to ascertain what any plant or animal is, which you may collect in your walks and excursions.

Shells of the cockle kind, that is, shells answering to the definition of the genus above given, are found in the seas of almost every part of the world. Many of them are of great beauty, and some are accounted very valuable. Mr. Wood, in his excellent work on Conchology, states, that the late eminent Dr. G. Fordyce refused fifty guineas for a

specimen of the smooth-keeled heart-cockle (Cardium *humanum*), a small shell which inhabits the Eastern Ocean. Some species are covered with spines; and it is said that these do not conceal themselves in the sand, as the smooth ones do, the spines protecting them from enemies; but it is more probable that they serve to keep them fixed on the bottom, so as to resist the action of the waves, which otherwise would detach the shells from their place. The common cockle is much used as an article of food, and is common on most sandy shores, being buried a few inches beneath the surface. They are eaten raw, boiled, or pickled; and are brought to market early in February. Vast quantities are stated to be used in Holland, where, in winter, they form an important article of food.

Our third shell, an example of the univalves, is the common periwinkle (Turbo *littoreus*); but I fear it would be tedious to occupy you with more observations on the mode of studying Conchology. I shall, therefore, refer you to works on the subject; and if you can get oral instruction from any scientific friend, your progress will be greatly hastened. In Burrow's Elements you will find a very good plate, explanatory of the different parts of univalves; and by a very little practice you will soon become master of all the terminology which conchological science requires. I may observe, that a person may live at the sea-shore, and yet have very little opportunity of collecting or studying shells; for some coasts are exceedingly barren of such productions. Sheltered bays in estuaries and friths are most prolific in them; and in intertropical latitudes

they are much more abundant, and beyond all comparison much more beautiful, and more singular in their forms and colouring, than those of temperate or cold climates. The value set on some foreign species amounts to a great degree of absurdity. A specimen of one variety of that species of cone-shell, called Conus *cedo nulli*, which is not more than about two inches long, and is now in Paris, has been valued at three hundred guineas. One species of Turbo, also named the wentletrap (Turbo *scalaris*), being very scarce, has always been held in great value. Mr. Dillwyn observes of it, that "large and perfect specimens formerly sold at very high prices; and one, which now belongs to Mr. Bullock, has been valued at two hundred guineas. Da Costa, in his Elements of Conchology, relates, that in 1753, at the sale of Commodore Lisle's collection, four of these *wentletraps* were sold as follows:" —

	£	s.	d.
First day, lot 96. one not quite perfect -	16	16	0
Third day, lot 98. a very fine and perfect one -	18	18	0
Fourth day, lot 101. one for - -	16	16	0
Sixth day, lot 83. one for - - -	23	2	0

There are many other shells which bring very high prices; and as the value depends, in a great measure, on the scarcity of the species, one might purchase a handsome collection for a sum which would buy only a single very rare specimen.

I shall now take leave of the shore, by observing, that the sea furnishes a copious store of materials for the naturalist. Besides the shells, there are the

fishes, the crustaceous or crab tribes, the star-fishes, the medusæ, corals, corallines, sponges, aphrodites, and a long list of other animal productions, independent of the fuci, ulvæ, confervæ, and other plants known by the general name of sea-weeds. Many of the latter are peculiarly beautiful, and when well preserved on paper form an interesting herbarium. I have remarked, this summer *, which is unusually wet and cold, that these sea-plants are rather scarce at Larne, a place where, in general, they are very plentiful. I apprehend that they are much influenced by the sun; and that when the seeds ripen, it happens with many species that they separate from their roots, to be conveyed away by the waves or currents, in order that the seeds may be disseminated. This, perhaps, will account for what I have repeatedly observed of Fucus *punctatus*, F. *plumosus*, F. *pinnatifidus*, F. *purpurascens*, and some others, that when in fructification they are always thrown ashore in much greater quantity than at other times.

There is a very common coarse fucus, the sea-oak wrack, Fucus *vesiculosus* of Linnæus; the species, I believe, most commonly called alga marina, which is much used by the poorer classes at Larne for feeding pigs. Boiling water is poured upon it, which softens and renders it glutinous; it is then mixed with greens or potatoes, or even given by itself. Many persons have assured me, that the pigs are not only very fond of it, but that they thrive upon it remarkably well. Other sea-weeds might, probably, be used with advantage for the same purpose.

* 1830.

I had intended to make, now, some observations on rural scenery, and to offer you a few reflections on the history of some indigenous trees, and their importance in landscape; together with allusions to some other animals and plants besides those I have already mentioned; but there is, perhaps, no occasion; for, as I have meant these letters to be but introductory to other series with which I hope to follow them up, my chief object is, I conceive, in a great measure, accomplished in what I have written. That object has been to impress on your mind a conviction, that in truth the great and paramount good of the study of natural history is to direct our thoughts in a sensible and manly way to the Creator of all; to show that there is a constitutional feeling in our minds for the sublime and the beautiful in nature; and that, by investigating the minuter productions of our globe, for which perhaps curiosity is in the first place the natural stimulus, we come still more closely to perceive the power, and wisdom, and wondrous operations of Divinity, than even in the greatest and sublimest scenes which landscape can afford. And it is with the detail of these minor productions you must be chiefly engaged, as a scientific naturalist, in your future studies. In your own mind there is a principle which, of itself, if it be allowed fair play, obliges you to be impressed agreeably by the sight of a fine waterfall, the picturesqueness of an aged oak or time-worn ash, the shade of woods, the gurgle of streams, the sounds of the ocean wave, as it murmurs on shelving sands, or talks in thunder on rocks and precipices. These, and other general

components of nature, have only to be seen or heard, that they may come home with power and effect to the mind. When I see a chain of mountains rearing their summits to the clouds, do I not immediately pronounce it to be a sublime object; and that, without any one idea intervening between the moment of sight and the moment of feeling? When a person for the first time beholds the ocean, is he not rapt in astonishment, and awed by its grandeur, independently of any association of ideas? If to-day I admire the *beauty* of the cool, transparent, glassy flow of a river, and if to-morrow I behold it swollen to twenty times its usual magnitude, the water changed by a heavy night's rain to a dark brown colour, and the rolling flood dashing with incessant roar over "foamy steeps," or sweeping down its more level channel, boiling and flashing in its progress to the main, am I not *at once* impressed with the *sublimity* of the spectacle? or must I first think of flooded fields, or drowned cattle, or swept-away bridges, or undermined trees and banks? Surely not; the very first glance of the vexed torrent excites the feeling as instantaneously as a spark explodes gunpowder. I require no associations, no preparatory thinking; but a sentiment of sublimity and grandeur at the sight is at once called up, I know not how; but I am satisfied that it is neither artificial nor acquired. I believe the feeling of the sublime and beautiful in nature to be truly innate, and that its great value lies in its elevating our thoughts to the Deity himself. And how numerous are the lovers of general nature, in obedience to this innate feeling! How full of

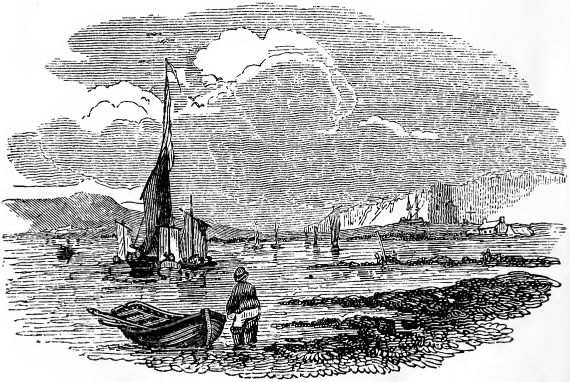
poetry, that language of heaven, is nature in all her amplitudes! and how indelibly rooted is the recollection of her scenes! how faithfully do they remain as they first fixed their impressure on the young mind! and how permanently do they continue to call up sensations of pleasure and delight!

> "O nature! woods, winds, music, valleys, hills,
> And gushing brooks! — in you there is a voice
> Of potency — an utterance which instils
> Light, life, and freshness, bidding man rejoice
> As with a spirit's transport: from the noise,
> The hum of busy towns, to you I fly:
> Ye were my earliest nurses, my first choice
> Let me not idly hope, nor vainly sigh;
> Whisper once more of peace — joys — years long vanish'd
> by." *

But if the great features of nature be so impressive, how much is to be found in her minuter details when they come to be investigated. If a writer mention a forest, a cataract, a storm, a calm, a desert, or a paradise, and adapt his language to the object, all understand, and all are pleased, or delighted, or instructed, in proportion as he exhibits genius and truth. And when we examine the minuter parts of creation, they also can excite no little admiration, while they give a deeper and more certain and solid knowledge of the power and goodness of God. The catalogue of the great features, too, is in comparison limited; while in the minuter departments, the number of organised beings, of geological, physiological, and other phenomena of the highest interest, are absolutely not to be num-

* Wiffen's Aonian Hours.

bered. And here there seems to me to be a wide and material distinction. The great forms of nature every one is impressed with from a constitutional innate feeling. The lesser are left to man himself to investigate, by his own research and the exercise of his understanding: they are innumerable; and we every where in them find an incomprehensible wisdom directing to certain useful ends, and unfolding a knowledge not only of the things, but of the mighty Being whose work they are. Let it not, then, be supposed, that the studying and collecting animal, vegetable, or mineral productions is a trifling occupation; for however general that opinion may be, it is as erroneous as it is vulgar.



LETTER XIX.

I WILL now occupy your attention for a little in making some remarks on a theme which, I fear, has seldom been submitted to your consideration, or impressed on your mind as being of any moment; I mean humanity to animals,—a subject to which I have several times alluded before, but which I shall now more particularly press upon your notice. That there are men in the world whose dispositions are diabolically cruel, we have but too many proofs. The newspapers contain weekly accounts of outrages committed against every feeling of humanity, both as regards our own species and other animals, and which are too often committed without any motive save the wanton indulgence of a bad and cruel mind; though I regret to say, that if any end is to be gained, however slight, and that even by the exercise of the most severe cruelty, the latter forms, too often, no bar whatever in the way: hence it was once, and I fear still is, the practice, in some places, to whip pigs to death, because their flesh was thought to be improved by it. In these countries, calves are drained of their blood, and made to feel, by repeated operations, all the miseries of exhaustion, merely to make the veal of a whiter colour. Lobsters are brought to market with pegs of wood thrust into one of their claw-joints to keep them from opening,

which, though it must produce continued and dreadful pain, saves the slight trouble of tying them with a bit of cord; and that is enough.

Your own recollection will recall but too many other examples of cruelty; but if you have not read of the experiments made by anatomists on living animals, you will still have an imperfect idea of the horrible excesses which are committed. The slightest matter of the merest curiosity is made the pretext for mangling living animals in the most dreadful way that can be imagined. It is not always, I must observe, in consequence of a theory being formed, and a belief that if proved true it might be of importance to our species, that experiments are made to determine its correctness or fallacy. In France, especially, the most barbarous cutting up of living animals is pursued with a savage and reckless enthusiasm, not for the purpose of verifying a probable, and, if true, important conjecture, but to ascertain what effects are produced by such butchery;—I hesitate not to use the word, for it is the fittest that could be selected. Experiments of this description are unhallowed in their nature, and they will, almost always, be unsatisfactory in their result to a rigid investigator of truth; for a conclusion can seldom be depended on, which is derived from observation of a mangled suffering creature bleeding under the dissecting-knife.

That experiments have sometimes led to a little increase of certain knowledge, I know; but their frequent repetition, after all has been proved by them that is necessary, every humane man must deprecate: and still more is it to be regretted, that

the prosecution of experiments on living animals is recommended to students, to boys, as a useful mode of employing their time and improving their minds. I can find no excuse for any man, who will dissect living dogs, rip up their bellies, (or, as the softened phrase is, lay open their abdomen,) cut out their stomach, or spleen, or kidneys, or perform other dreadful mutilations, merely to satisfy a feeling of curiosity; and still less do I think that he can be excused for recommending such practice to his pupils.

One would suppose that the determining such a question, as whether, in vomiting, the stomach acts alone, or is assisted by the diaphragm and abdominal muscles, or is altogether passive, would scarcely be thought worth the sacrifice even of one dog — by any man, at least, who had ever himself felt what pain is, were it but that from the prick of a needle or of a thorn lodged in the finger. Yet this unimportant matter, this subject of curiosity alone, which is not of the slightest consequence, whatever way it might be settled, has been the cause of innumerable living dissections, the very least of which is sufficient to make one's blood run cold. Let any one who has ever experienced nausea and sickness for ten minutes, think what must be the sufferings of a creature whose belly is ripped open and emetics injected into its stomach; or what must be the agony produced by cutting away its stomach altogether, and sewing a bladder in its place — thereby substituting, for the purpose of experiment, an artificial stomach. These and similar barbarous but really useless experiments have been repeated over

and over, with a perseverance which is perfectly disgusting. Think of a dog being tied down to a table, the whole fleshy walls of its belly being cut away with a knife, and experiments made on it in that dreadful and pitiable state, for the purpose merely of ascertaining whether it will vomit or not. "An animal," Magendie observes, "still vomits, though the diaphragm has been rendered immoveable by cutting the diaphragmatic nerves; it vomits in the same manner, *though the whole abdominal muscles have been taken away by the knife*, with the precaution of leaving the linea alba and the peritoneum untouched." *

Now, you will observe that I do not mean to inculcate the positive abstinence from experiments on any account whatever, for there may be circumstances which will fairly warrant their adoption, though a humane or just man will never have recourse to them, either for the purpose of determining a question of mere curiosity, or of light importance; neither will he repeat them unnecessarily. But the practice, especially of the French physiologists, is very different. They torture animals innumerable, almost without end or aim, farther than *hoping* to get at something; like a child who breaks a watch in pieces thinking to obtain thereby a knowledge of the reason why it ticks. Many hundred dogs have been dissected alive, to prove whether the stomach is active or passive in vomiting; but I would ask, When an animal is writhing in agony, struck with

* Magendie's Physiology, translated by Dr. Milligan, ed. 3. p. 287.

dismay and astonishment, with its belly opened and its bowels exposed to the atmosphere, are we to expect that, in all the horrors of this situation, the stomach will exhibit itself, or perform its functions just as if nothing had happened? I cannot believe it; and if ten thousand such experiments as this were made, there still will and must be a want of proof. The stomach may in such circumstances be passive, though in the natural state of the animal, it may be active in vomiting; and, in fact, after all the cruelties which have been practised by physiologists, we do not at this moment know whether, in the natural and unmutilated state of an animal, the stomach contracts in vomiting or not, and, fortunately, this is of not one straw's consequence.*

* Since writing the above, I have noticed the following very satisfactory remarks on this subject, in the seventh edition of C. Bell's Anatomy and Physiology of the Human Body, vol. iii. p. 275.: —

" There is a very curious experiment by M. Magendie, which has much puzzled physiologists. He cut out the stomach of a large dog, and substituted in its place a bladder, which he fastened to the œsophagus, and having excited *vomiting*, by pouring emetic solution into the veins, the contents of this bladder were discharged as from the natural stomach. The conclusion has been too hastily formed, that the stomach has therefore nothing to do with the action of vomiting. But it ought to be recollected, that the bladder represents a relaxed stomach, whereas the stomach is muscular and active, and capable of resisting the action of the abdominal muscles and diaphragm, unless there be a consent of the action of the stomach, and the action of the muscles of respiration. Thus, if we could suppose that a man had a distended bladder for a stomach, whilst he exerted himself forcibly and retained his

I believe, also, that little or no confidence is to be placed in the accuracy of conclusions respecting the natural functions of viscera drawn from observation of what occurs in animals labouring under extreme suffering and terror. The pancreas, for example, has always been considered as a gland similar to those which produce the saliva, but whether its secretion were exactly the same, or different, its large size is a pretty good presumptive proof that the quantity of fluid it prepares is not very small. The duct or tube through which the pancreas empties its secreted fluid opens into the first of the small intestines; now, if a dog be tied down and his abdomen be laid open, or, as I have already remarked, if, in vulgar phrase, his belly be ripped up, the hands introduced among his bowels, and the portion of intestine to which the pancreatic duct goes be slit open, can I, in fairness and truth, trust to any result in this case which may be obtained from observation of the quantity of fluid secreted by the gland during so horrible a process? I say,

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breath, the contents would be discharged. So would they, if he lay with his belly over a yard-arm. But no such discharge takes place from the natural body, because the upper orifice of the stomach resists! This resistance does not take place in vomiting; and therefore, I say, the stomach has to do with vomiting, in spite of all the cruelties which have been committed. The lower orifice is contracted, the coats of the stomach are contracted, and the upper orifice is relaxed in the act of vomiting, while the power of ejecting the contents is very principally owing to the violent throes and contractions of the abdominal muscles and diaphragm."

it would be unphilosophical to have any such trust, and I would look on almost all opinions formed on data so unnatural, as unsatisfactory and valueless. Magendie thus describes his mode of collecting this fluid:—"I lay bare the orifice of the canal in a dog, I wipe the surrounding mucous membrane with a very fine cloth, and I wait until a drop of liquid passes out; as soon as it appears, I suck it up with a *pipette*, an instrument used in chemistry. In this manner I have succeeded in collecting some drops of pancreatic juice, but never enough to analyse it according to rule." He also says, "What I have been most struck with in endeavouring to procure pancreatic juice, is the smallness of the quantity which forms it; a drop scarcely passes out in half an hour, and I have sometimes waited longer for it. It does not flow more rapidly during digestion; but, on the contrary, it seems slower. I think it is generally more copious in young animals."* At page 212., however, of the same work, the account of the quantity secreted is a little different. "Sometimes," he says, "a *quarter* of an hour passes before a drop of the fluid springs from the orifice of the canal which pours it into the intestine;" and in the next paragraph he observes, that he has seen "the flowing of the pancreatic fluid take place in certain cases with considerable rapidity." The term *considerable rapidity* is very vague; but it shows that the secretion was in some cases much more copious than in others, and is a farther proof of

* Magendie's Physiology, translated by Milligan, ed. 3. p. 457.

the great uncertainty that always must and will attach to experiments of this character.

But it may be objected, that a similar exposure of the bile-duct shows that the bile is constantly pouring from *it* into the intestine. But if we suppose, as has been generally done, that the pancreas is in truth a salivary gland, we may readily conceive that, as in those of the mouth, the effect of terror and acute pain will be to suspend its action; for every one knows that both of these cause a great decrease or suspension of the flow of the salivary secretion, and an ardent desire to take drink. This is very obvious in tedious surgical operations. If therefore pain and terror suspend the action of the salivary glands in the mouth, we may well suppose that the same causes will suspend the secretion of the pancreas.

I believe myself to be amongst the last persons who would be inclined to throw any impediment in the way of improvement or knowledge; but I most conscientiously believe, that in attempting to excite your detestation of such cruelties, I am speaking the language of truth, as well as of mercy. What, again, is to be expected of a young medical man who acquires a taste for dissecting living animals? Is that the way to pursue his studies with advantage? Is it not most likely to draw him from the legitimate study of his profession? In place of storing his mind with a knowledge of chemistry, materia medica, human anatomy, and the other fundamental branches of medicine and surgery, he is employing his time in cutting up living cats and dogs, in the hope, perhaps, that he too may become a discoverer; or as likely, it

may be, from mere idleness. I am sorry that in our own islands it is common among teachers of anatomy to recommend the practice of vivisection to their students; but then, this recommendation is merely to "make experiments on the lower animals." Yes; but this making of experiments includes every species of cruelty that the most savage ingenuity can invent; it includes sawing off portions of the skull and paring away the brain in slices, to see what effect is produced by wounding one part more than another: it includes the starving of animals to death, for the purpose of ascertaining the appearance of their stomach: it includes the tying of ligatures on the bile-duct, the thoracic duct, the pylorus, and other parts, all which is accompanied with excruciating torture to the victim operated on: it includes the laying bare of the heart, to observe the strength of its action, dividing nerves, cutting away viscera, and many other operations which are acompanied with the direst cruelty, and nine tenths of which, after all, relate to matters of curiosity alone, and lead to no practical benefit of any kind.

It may be curious enough, that, when a particular part of the brain is wounded, the animal has a tendency to move forward; when another, to move backward; and when a third and a fourth, to turn round; but I cannot think the knowledge of these circumstances by any means worth the price it has cost; and, after all, it merely shows what takes place when the brain is denuded, and wounded, and, consequently, its *natural* function deranged, if not destroyed. Putting aside the sufferings of the thousands of animals which have been sacrificed in

experimenting and exhibiting these phenomena in lectures and demonstrations, I cannot but think that the witnessing of such cruelties must have a very demoralising effect. I cannot conceive how a person can become coolly reconciled to the sight, even of such murderous acts, and continue to retain proper feelings of humanity for his own species. In this I may be wrong; but whether or not, I am satisfied that to recommend to students the pursuit, or even to exhibit to them the view of such dissections as I have adverted to, is to run the risk of making them at once cruel and speculative, and at the same time neglectful of those branches of solid knowledge which will qualify them to be truly useful in their profession.

I know it is often urged, that medical knowledge has been greatly improved by experimenting in this way on animals. That it has been a little, I will grant, but only a little; for the phenomena which take place in animals will often not apply to ourselves in the practice or treatment of either wounds or diseases. Experiments to determine the action of poisons, and ascertain their antidotes, are, perhaps, or at least were, more allowable than any others, but the discovery of the stomach-pump is of more value than all that ever have or could have been made. And yet, so differently do poisons act on different animals, that no observation drawn from their action can be applied to man. Hemlock, as every one knows, is a wholesome food for the goat, but it poisoned Socrates; while, on the other hand, a dog will be destroyed by a quantity of nux vomica, which a man can swallow with impunity.

That experiments on animals may sometimes be accounted necessary or desirable, I have already admitted; and I refer you to Mr. Bell's most admirable book on the Natural System of the Nerves * for an example of the true principles on which such experiments ought to be conducted: — an example where the end was legitimate, and where the humanity and good sense of the operator were such as not to lead him either to put the animal to extreme suffering, in which state little can be depended on, nor to any unnecessary repetition of his experiments.

From what I have now written, you will, perhaps, account me morbidly compassionate; and, indeed, there is so little feeling among mankind for the sufferings of animals, that I should be rather surprised if you thought otherwise. But the true evil is, that humanity is neglected to a most culpable degree. It is a virtue that is inculcated neither on youth, nor age, nor sect, nor party; and, from custom, we every day see, without emotion, acts of cruelty which, only that we have been long used to them, would excite our deepest indignation. Look, for example, at the treatment of the horse. That poor slave, so useful to man, is subjected to hardship, pain, and suffering, to a degree that would seem utterly incredible, were we not, all our lives, accustomed to the sight.

The horse's skin is remarkably sensible; and it is only after the daily or hourly infliction of the whip for years, that it at last becomes comparatively

* An Exposition of the Natural System of the Nerves of the Human Body, &c. By Charles Bell.

callous. Pampered, perhaps, in his better days, he passes successively from hand to hand, every new change of his condition being a change for the worse, from one step of misery and hardship to another, till, curtailed of more than half his days, he at last gets freed from the brutal unfeeling tyrants under whom he dragged out his weary existence. The *wanton* infliction of pain, too, on the horse, is exercised in a most shameful manner. One might suppose, to observe the conduct even of many well-educated men, that they thought him merely intended by nature to undergo a life of flogging, buffeting, and fatigue. Then look at the merciless rate of travelling, and the inhuman loads which have to be dragged along under the perpetual torture of the whip. Lift up the collar and see the red raw flesh, which, at every step, receives a new wound from the pressure and friction of that part of the harness. Recollect the pain produced by the slighest touch on your own skin when rendered raw by a blister or other means, and try to conceive what must be the sufferings of thousands of stage-coach and other horses, under the united miseries arising from abraded skin, excessive fatigue, daily cutting with the whip, and often, what is equally bad, the wanton brutality of ostlers and stable-boys.

If an animal were tied to a stake, and flogged regularly four hours a day, who would not exclaim against the brutality of the act? Yet the horse, in innumerable instances, suffers far worse, and no one cares. Besides a much longer infliction of the whip, in many cases, there is the excessive fatigue, a feeling even worse than pain; it is suffering of a very

intolerable kind; yet so little is our humanity, that driving a horse to death, if he be old at least, and his strength gone, so that the pecuniary sacrifice is not great, is a matter of almost perfect indifference; and in stage coaches, generally speaking, the horses are driven with calculating nicety so far as nature will hold out, without actually giving way altogether under the accumulated suffering and exhaustion.

The want of humanity to animals, which is every where so glaring, cannot, I think, be a natural defect of the human mind, but is the offspring of a wrong education, and an unjust and arrogant conceit that man is the only being of any consequence in this world; and that it matters not what becomes of others, or what they may suffer, provided he reap the slightest benefit. Some anatomists even hold out as one reason for making experiments on animals, their not being destined to immortality. But if they be, indeed, "the beasts which perish," should not justice teach us to render their temporary lot as easy as possible. Man may persecute man, but hope will still lie in the bitter cup, and visions of brighter times will illumine the present gloom of misery. The slave, writhing under the whip of a savage master, may indulge in the inspiring thought of being at length released by death from the cruelty of his persecutor, and of enjoying for ever the happiness which he in vain had prayed for here. The prisoner, chained in fetters, and languishing out his life in a dungeon, lives in expectation, that should he not be restored to freedom, death will at length strike off his bonds,

and usher him to eternal bliss. But what counterbalance to its misery has the poor brute whose life is one continued unbroken series of suffering? It has no heaven to look to, no bright anticipation of a period when misery shall cease, and happiness be enjoyed. Its life is its little all, and *that* the general tyrant renders a curse to it while it lasts, or takes from it by an infliction of the severest torments. But the lower animals are the "beasts which perish," and therefore not to be cared for further than they can be useful to us. I will not attempt to argue the question, whether death annihilates them or not, but there are very wise men in the world who think, that as much proof lies on the one side as on the other; and at all events, a benevolent mind will pity their sufferings, and attempt to relieve them, whether they perish or not.

I hope that what I have said respecting the exercise of humanity to animals, will awaken your attention to that virtue. Neither punishment, indeed, nor reward, are any-where held out as inducements to its practice; but it is therefore not less a virtue, and you will have the satisfaction, at any rate, of *doing good for its own sake*,—a thing, I fear, of not common occurrence in the present constitution of things. The brutal sports, which were formerly so frequent, especially bull-baiting, bear-baiting, badger-hunting, and cock-fighting, have been greatly lessened, which I suppose is owing to the more general diffusion of useful knowledge among all classes, especially the better. The lower orders have not the same encouragement in pursuing these

detestable sports from their superiors in wealth and consequence as formerly, and hence their frequency has abated. The still more brutal practice of prize fighting, I am glad to see, is also on the decrease; and I entertain some hope of yet seeing the time when one may express disapprobation of such inhuman brutalities, without being considered either foolish or ridiculous.

I exceedingly regret that so much more remains to be said on the subject of this letter; but it would be painful for you as well as me to dwell any longer upon it: it appears but too plain, that so much cruelty continuing still to be practised in this age of civilisation and knowledge, shows that something generally and radically bad exists in the usual mode of forming the minds of youth.*

* The following note, attached, along with many others characterised by much learning and research, to a sermon by my brother, entitled "Humanity to Animals, the Christian's Duty, a Discourse by William Hamilton Drummond, D.D." published 1830, may be introduced here with advantage.

Many divines of distinguished reputation have advocated the cause of animals, but, strange to tell, not always with the approbation of their hearers. In 1772, the Rev. James Granger preached a sermon on this subject in the parish church of Shiplake, in Oxfordshire. This sermon he published, for the singular reason that it had offended all who heard it, as he himself informs us in the following postscript: — "The foregoing discourse gave almost universal disgust to two considerable congregations. The mention of dogs and horses was considered as a prostitution of the dignity of the pulpit, and a proof of the author's growing insanity.* * * It is, with great humility, submitted to the judgment and candour of the public, and particularly to the cool consideration of those who were

With regard to the virtue of humanity as exercised towards your own species, I would wish you to have

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pleased to censure it, and by whose disapprobation, without any premeditated design of the author, it now sees the light." It was dictated, he says, by his heart, and assuredly it contains nothing offensive to good feeling or good taste, to morality or religion, much less to the *dignity of the pulpit.* It is prefaced by a dedication to *T. B. Drayman*, written in a strain of original caustic humour, on the principle, I suppose, of Horace: —

——— "ridiculum acri
Fortius et melius plerumque secat res."

As some may be gratified and others benefited by its perusal, it is here subjoined, —

"Neighbour Tom,

"Having seen thee exercise the lash with greater rage, and heard thee swear, at the same time, more roundly and forcibly than I ever saw any of thy brethren of the whip in London, I cannot help thinking that thou hast the best right to this discourse. But I am afraid, Tom, that I shall in some parts of it appear to thee to be as great a *barbarian* as thou seemest to me a savage. If thou findest any hard words in it, come to my vicarage-house, and I will endeavour to explain them to thee in as familiar language as thou talkest to thy horses. For God's sake and thy own, have some compassion upon those poor beasts; and especially to the fore-horse of thy team. He is as sensible of blows as thou art, and ought not to have been so outrageously punished for turning aside into a road to which he was long accustomed, when thou wast fast asleep upon thy dray. If thou breakest any more whips upon him, and repeatest thy horrid oaths, wishing thyself 'damned and doubly damned,' if thou art not revenged of him, I shall take care that thou be punished by a Justice of the Peace, as well as by thy own master in this world; and give thee fair warning, that a worse punishment awaits for thee in the next, and that

an ever-present conviction, that only for circumstances, you yourself might have had a very different lot from what you enjoy; that millions who are sunk in ignorance, and "steeped in poverty to the very lips," would, with your opportunities, have been your equals or superiors in usefulness and talent; that you should always curb with a strong hand the suggestions and workings of an overweening self-pride; and that when you give charity or advice, or render your good offices in any shape to your less fortunate brethren of the human race, you should act on the pure and unadulterated principle of doing good for its own sake, and from a sympathy of feeling for the privations and misfortunes of your fellow-men. An action, however good or charitable it may be in its effects, if it be performed either from a hope of reward, or through a fear of pnuishment, let us call it what we will, is not an act of virtue.

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damnation will certainly come according to thy call. I, however, hope better things of thee, and that all thy punishment will be in this life. It is not likely that thy soul, when separated from thy body, will sleep till the day of judgment. According to the doctrine of a very sensible man, it may inhabit the fore-horse of a dray, and suffer all the pain that guilt and whipcord can give. In a word, Tom, I advise thee to fall on thy knees, and ask God forgiveness for thy cruelty and thy oaths, and to be careful for the future not to sleep upon the road; and to drink less ale, and no drams; so shalt thou save thy whips, and thy horses, thy body, and thy soul.

"I am, Tom, thy friend and well-wisher,

"James Granger."

LETTER XX.

My chief object in the preceding letters has been to impress upon your mind the importance of studying the works of Nature with a continual reference to the great and Almighty God, whose offspring they are: and though the observations contained in what has thus far formed our correspondence are not very extensive, yet they are still, I hope, of sufficient variety and value to stamp a deep conviction on your mind that Natural Religion is a subject of the highest moment to an intelligent being; that it should not be neglected; that it forms a source of the purest contemplation; and that it gives us the most exalted conceptions of the power, wisdom, and beneficence of the Deity. But if this be so, why is it, as respects the great mass of mankind, almost a dead letter? That it it is so, cannot be denied. Where is it taught to them? From what chair is tsi study recommended? Is it considered by the learned, in general, as worthy of consideration? or is it in any way given to those who would, from their sincere love of truth, consider it as invaluable?

It may be said, indeed, that there have always been writers on Natural Theology. Cicero, for example; and, in England, Ray, Derham, Paley, and others. This is very true; and I wish the number

of writers on it had been tenfold greater than it has; but, still, natural theology never has been taught to the people in any country, nor pains been taken to raise it to the elevation it deserves; on the contrary, indeed, superstition, ignorance, and motives of self-interest, are ever active in disparaging and suppressing it. To children, especially, I consider that we act with the greatest injustice; for they almost all are eager for a knowledge of the productions of nature; and the fund of information which might be imparted to them, combined with impressive illustrations of the power and goodness of their God, could not fail, whatever religious tenets they might be brought up in, to have a beneficial effect on all their future life.

For communicating a knowledge of natural history to youth, much might be accomplished by attaching to seminaries of education, collections of specimens from the different kingdoms of nature, and employing works on natural history among the regular school books. The Menageries, Insect Architecture, Insect Transformations, Vegetable Substances, and those volumes on similar subjects, in the "Library of Entertaining Knowledge," are admirably adapted for somewhat advanced scholars, whether boys or girls. A microscope also, as has been recommended by the highly talented editor of the Magazine of Natural History, &c. Mr. Loudon, should form an indispensable requisite of every boarding school; and the scholars, not mere children, should each possess a magnifying glass, for examining small objects, especially minute flowers.

One great object, however, in all these places, would be, that the teachers should cultivate in themselves a taste for natural history, as that would give them the means of imparting a knowledge of it in many ways to their pupils. But now comes the bugbear question, which is so often the fertile source of hindrance to improvement — "Will it not take them off their other concerns?" I answer, No. My friend, the Reverend R. J. Bryce, principal of the Belfast Academy, and his brother, James Bryce, Esq., who, for some time have had a collection attached to their excellent place of education, have satisfactorily proved this, by showing how the thing works in actual practice; as the following letter, which, at my request, those gentlemen have been kind enough to furnish me with, will fully explain:—

"*Belfast, 30th August*, 1830.

"My dear Sir,

"I have great pleasure in giving you, according to your request, a statement of the circumstances connected with the introduction of natural history as a regular part of the course of elementary education given in this seminary.

"The academy, as you are aware, consists of a number of distinct schools, each superintended by a master who gives his whole attention to his own department, and receives the whole of the profits arising from it; and it is the duty of the principal to see that each master conducts his school with diligence, and on a judicious plan. Several attempts had been made to introduce the physical sciences

into the mathematical school, but with little success. A few of the advanced pupils were occasionally taught the elements of natural philosophy and of chemistry, but there was very little demand for such instruction. At length, in the summer of 1828, my brother, who, on my appointment to the head of the academy in 1826, had succeeded me in the charge of the mathematical school, fortunately thought of adding mineralogy and geology to the usual course of geography. This was, in fact, only completing the geographical course by the addition of physical geography, which had till then been omitted. The pupils, whose ages varied between the extremes of eight and eighteen, all entered with the greatest eagerness into these subjects; so much so, that at first I was short-sighted enough to feel some apprehension of their being led away from their severer studies by this new and fascinating pursuit. But I was soon set perfectly at ease; for there was, in a very short time, a marked improvement in the manner in which the other parts of their business were performed by those lads who had given themselves most passionately to mineralogy and geology. This was what I ought to have expected. When a taste is formed for any one intellectual occupation, it is easy to ingraft upon it a fondness for another. When a boy has found pleasure in exerting his faculties upon one subject, he is naturally led to try them upon others.

"But this was not all. Several of the young mineralogists had been introduced by my brother as visiters at the meetings of the Belfast Natural

History Society, of which you know he is a zealous member. They had been pleased; and they wished to have some better means of enjoying such pleasure than by being spectators. Accordingly, one morning, after the lecture, they surprised their teacher by laying before him a plan for the establishment of a similar society among themselves, which they proposed to call 'The Academy Natural History Society,' and of which they requested him to become president. My sanction, as head of the academy, having been asked, and given most cordially and joyfully, the Society was constituted accordingly, for the objects 'of giving mutual instruction in the various departments of natural history, and of forming a museum for the academy.' This took place on the 30th of October, 1828, at which time the academy did not possess a single specimen, nor a box or shelf in which specimens could be kept. It has now a collection of minerals, which, for the value of the specimens and completeness of the suites, has been pronounced by good judges to be the third or fourth in Ireland. There are also a few good specimens of stuffed birds, and a considerable number of shells. A glass case has been erected at an expense of about twenty pounds, in which the more attractive part of the collection is kept. The money required, was raised partly by contributions among the young people themselves, and partly by the donations of a few lovers of science in the town and neighbourhood, most of them belonging to the circle of my brother's personal friends. Of the specimens, the greater part have been either pur-

chased or collected by the individual exertions of the members of the Society. One shoots a snipe or partridge on a holiday; another contributes the *defleta membra* of his sister's canary bird; a third proudly deposits in the treasury of science the piece of rock-crystal, or calcareous spar, which he had hitherto regarded only as a glittering toy; an East Indian presents leaves from an Oriental plant, used for writing upon by the Birmese, and covered with characters; the captain of a West Indian ship presents a fine conch, or a magnificent piece of coral, to a young favourite, and it is joyfully transferred to the museum. The young naturalists, in their holiday excursions, are always mindful of an enterprise of which they are justly proud; every visit to the basaltic hills in the neighbourhood enlarges their already rich and beautiful collection of zeolites; and pupils from a distance bring, at the close of each vacation, the rocks and minerals of their native localities. And you are not to imagine that these young people possess a flimsy or superficial knowledge of the subject, or a mere knowledge of names. You will find them excellent practical mineralogists, capable of deciding accurately what specimens are worthy of being kept, and what are to be neglected or thrown away. And a continued series of exertions of this kind, where each individual service costs little or nothing, amounts to something in the end. After all, however, the chief part of the mineralogical collection has been purchased, with great judgment and to great advantage, out of the funds of the Society. Some valuable donations

have been received from *externs;* the most remarkable of which was a collection of native shells, containing about a hundred distinct species, gathered by a lady with her own hands cn the beach of Lough Foyle, for the express purpose of being presented to the museum.

"The Society of our young naturalists meets once a fortnight, when papers are read by the members in rotation, and conversations held, arising out of the papers.

"I consider this one of the most important improvements in education that we have yet effected, although we boast of some that are considerable. You are pleased to speak of me as having some share in this one; but I must disclaim all, except the negative merit of having encouraged and sanctioned it. The credit of the first thought, and of the persevering exertions which reduced it to practice, is all due to my brother James.

"I ought not to forget, that the parents of the children have noticed a marked change in the habits of such of them as have been taught geology. It has made them more animated and intelligent; and, by giving them a rational pursuit in their hours of amusement, has done more to 'keep them out of mischief' than any other thing that could have been devised; for all of them follow up the study more or less, and some so far as to form little cabinets of their own at home. Every sensible mother, whose son has passed through a geographical class for the last two years, has expressed herself highly delighted with the effects, intellectual and moral,

which the geological part of the course has produced on the boy's domestic habits.

"Wishing you every success in your laudable endeavours to promote the study of natural history,

"I am, my dear Sir,

"Very truly yours,

"R. J. Bryce."

With respect to the culture of natural theology among adults, it can only be generally diffused by the regular and frequent delivery of discourses upon it, and by publications explanatory of its advantages; and though it can only appeal to reason, and look to common sense and the book of nature, "that noblest of volumes, where we are ever called to wonder and to admire,"* for that support which it deserves, yet there is one advantage peculiar to itself, — that the works can be exhibited, and the mechanism and other wonders of the organised structure in the animal and vegetable kingdoms, and the arrangement of strata, the forms of crystals, the remains of extinct creations, and other phenomena of the mineral world, can be made apparent to the senses, thereby giving positive evidence of the truths which it teaches. And we are not to suppose that a previous course of training, or a particular kind of education, is necessary to enable us to understand these subjects. There is much, indeed, in the minute detail of every science which cannot either be well explained or understood in a

* Pirate. — Sir W. Scott.

popular discourse, but that does not affect the main object, — the communication of useful information which can be made plain to all.

Much good might be done both for natural history and natural religion, by societies formed for the express purpose of cultivating the one in order to inculcate the other. There are very many persons who, were they aware of the great utility of these studies in imparting a knowledge of the wisdom and other attributes of the Deity, and of enlarging the human mind, would be anxious to forward any judicious plan by which they might become more widely understood. It is, indeed, extraordinary to see what zeal is manifested, what pains are taken to gain proselytes, what sums are raised and squandered in supporting any new absurdity that starts up, pretending to be founded on miraculous claims or supernatural assistance, and yet to find that the great volume of creation is so much unknown and disregarded as it is. If a Joanna Southcote or other insane fanatic appear, there are thousands to become believers in the pretended mission; or if a Hohenlohe assume to wield the powers of Heaven, whole nations will rely on the faith of the unprincipled cheat. And can nothing be done to give men a knowledge of natural religion, which is, perhaps, the only cure for this silly and pernicious belief in wonder-workers and hot-brained or cunning knaves, who thrive by imposing on the weakness of their brethren? It is well known that a number of the clergy of the Established Church were firm believers in Joanna Southcote being the woman who was

"clothed with the sun, and the moon under her feet, and upon her head a crown of twelve stars;" * and that one of them even went so far as to offer a benefice into the hands of his bishop, if, on a certain day, the "holy Joanna" did not appear with the expected Shiloh; — an excellent specimen of faith, no doubt; but I will venture to say that these gentlemen did not spend much of their time in cultivating natural science, or contemplating the Deity in his works. It is said, indeed, that some of her disciples still suppose that Joanna is in heaven searching for the Shiloh's father; and what a miserably superstitious state must the world still be in, when we reflect, that though this impostor died so late as 1814, yet, at one period of her career, she had, in London and its neighbourhood, above one hundred thousand converts. †

Societies which would devise means of giving stated lectures on subjects demonstrative of the wisdom and other attributes of God as discovered in his works, whether in the structure of the heavens, or in the history and conformation of organised nature, or of the great features of our globe, would, I am convinced, do incalculable good. There is one recommendation of natural theology not a little powerful; which is, that men, by attending to it, would become possessed of more and more knowledge as long as they lived. So long as a man retains his faculties, there is still something more in it to be

* Revelations, chap. xii. ver. 1.

† See the London Encyclopædia, *in verb.*

acquired; and a discourse on science in connection with it, though attended to but once a week, would gradually bestow upon the hearer a large fund of knowledge, which would still be increasing, and which none, I presume, will dare to say would be a useless or unimportant acquisition. I again assert, what I am most assuredly convinced of, that the imparting a knowledge of the works of creation to mankind at large would prove to them a most valuable gift. I would like that a lecture-room, a museum, and a library, should be attached even to every village as regularly as its church or chapel; and that part of some set day or days should be appropriated to the demonstration and teaching of the works and wisdom of God in the great subjects of natural theology — whether in the sublime science of astronomy, or in the leading branches of natural philosophy, or in the economy, fabrication, and history of the individuals of the animal and vegetable kingdoms; in short, the wide and glorious field that occupies every page of nature's stupendous volume. This would be teaching men of every creed and every faith a kind of knowledge which must of necessity be useful to them. Let it not be said that such is taught! — the case cannot be made out; the people are taught no special knowledge of these things in any country upon earth.

You will, perhaps, treat the idea of teaching matters of science to people generally as chimerical; but be not over-hasty. It is still too common a persuasion, that knowledge should be a monopoly, belonging solely to the learned and

highly educated; but there is a vast fund of information of the very highest value, which can be understood by persons who have had little previous tutoring either in school or university. There is a vast mass of knowledge which admits of easy explanation, and which could be comprehended by men of the most moderate education; and why is it withheld from them? Is the sun still to shine in the heavens, the planets to roll on in their orbits, the comets to shoot beyond imagination's wing into the regions of space, and the constellations to sparkle for ever on the canopy of night; and yet our brethren of the human race, a very small portion excepted, to know no more about them than merely that they are the sun and stars?

Will it be said that the great truths of astronomy can only be made plain to the understandings of those who are profound mathematicians and philosophers? There are lengths in every science, indeed, which can only be gained by long and deep study; but although it required a Newton to unfold the mystery of the planetary motions, as guided and controlled by the law of gravitation, still these motions, and most of the sublime facts of astronomy, can be comprehended by the bulk of the people, from plain illustrations, given in plain and perspicuous language. But of this, and of nature in general, they are kept in deep ignorance. Simple truths, when simply explained, are more easily comprehended, I believe, than is commonly supposed; and I feel satisfied, that the task of teaching mankind in general such solid and various knowledge as would tend most powerfully to advance both civilisa-

tion and morality, is any thing but hopeless. Knowledge has been truly said, by Bacon, to be power; and with equal, at least, if not greater truth, it may be asserted, that, when pursued with a reference to the God of all knowledge, it is virtue.

An acquaintance with nature must always tend powerfully to suppress the puerile and degrading belief in supernatural occurrences, and in pretenders to the working of miracles. The true place to search for what is really and irresistibly demonstrative of the Deity and his ways, is in the *accomplishment*, and not the *breach*, of those laws which he has established throughout nature; and all the miracles that have ever been reported are as a drop in the ocean, compared with the infinite power that is every where discoverable in his works. Where is the miracle, let me ask, that does not sink into comparative nothingness when compared even with the motion of so small a globe as the world we live on? The earth, you are aware, moves round her axis every twenty-four hours; and being eight thousand miles in her longest diameter, the consequence is, that any point at the equator will be carried round at the rate of one thousand miles in the hour. But the orbit in which the earth moves round the sun is known to be five hundred and eighty-four millions of miles; and as that space is described in one year, the average space gone over is nearly one million six hundred thousand miles in one day, which is sixty-six thousand six hundred miles in one hour, eleven hundred in one minute, and eighteen every second of time. So that even while you are occupied in reading this letter, supposing that to take up

the space of an hour, you will, independently of the diurnal motion, be carried on, in that brief portion of time, sixty-six thousand six hundred miles in your annual circuit round the sun. This is one of the many wonders which astronomy has disclosed of the omnipotent God in the economy of the universe: but whether we contemplate the heavens or the earth, wonder accumulates upon wonder, and proof upon proof. There is no limit to the study of the Almighty in his works. All nature, from the north to the south, and from the east to the west, offers examples innumerable of the power and wisdom with which he works throughout the visible world before us. In the heavens we find suns the centres of systems, and an endless series of rolling worlds; and when we descend from the consideration of suns and systems, of stars wheeling in their orbits with a velocity quicker than thought, of worlds compared with which the globe we inhabit is in magnitude as a molehill, how delightful is it to find that on this ball, insignificant as it is in comparison with thousands of the heavenly orbs, the God of all displays himself in characters not less strong, to the enquiring mind, than in the boundless ocean of space that holds the sun and stars!

Let us consider an insect, or let us study the laws which direct a planet; let us contemplate the solar system, or enquire into the history of an ant-hill or a honeycomb; the mind, the truly valuable portion of the compound called man, recognises in the vast, as well as in the minute, and *vice versâ,* the master mind, the God, the omnipotent power — express it by what name we will — which formed

and which governs the mighty whole, in all its magnitudes, in all its minima. Paley observes, in his Natural Theology, — a work which I can never too highly recommend to your notice, — that "the works of nature want only to be contemplated. When contemplated, they have every thing in them which can astonish by their greatness: for, of the vast scale of operation through which our discoveries carry us, at one end we see an intelligent Power arranging planetary systems — fixing, for instance, the trajectory of *Saturn*, or constructing a ring of two hundred thousand miles diameter, to surround his body, and be suspended like a magnificent arch over the heads of his inhabitants; and, at the other, bending a hooked tooth, concerting and providing an appropriate mechanism for the clasping and reclasping of the filaments of the feather of the humming-bird. We have proof, not only of both these works proceeding from an intelligent agent, but of their proceeding from the same agent: for, in the first place, we can trace an identity of plan, a connection of system, from Saturn to our own globe; and when arrived upon our globe, we can, in the second place, pursue the connection through all the organised, especially the animated, bodies which it supports. We can observe marks of a common relation, as well to one another, as to the elements of which their habitation is composed. Therefore one mind hath planned, or at least hath prescribed, a general plan for all these productions. One Being has been concerned in all."

I hope you are now satisfied that the pursuit of

natural history is one that should neither be considered as idle nor undignified; and I also hope that you are inclined to believe, that "if one train of thinking be more desirable than another, it is that which regards the phenomena of nature with a constant reference to a supreme intelligent Author." * But if this be true, how desirable would it be that some means were devised to diffuse a knowledge of nature, and to promote this mode of contemplating her! We have Sunday schools for the young, and why not Sunday colleges for instructing the adult part of the population? When we recollect, that in the support of the Established Church of Great Britain and Ireland, not less, perhaps, than twelve millions sterling are annually expended—that large voluntary contributions, amounting to some hundred thousand pounds every year, are raised for Missionary, Bible, and other societies, besides the great expenditure required for the support of teachers of independent sects; that the steeple alone of a church will sometimes cost more than would found a university,—is it not somewhat remarkable that nothing is done to give mankind some knowledge of God, as he exhibits himself in his works? I am perfectly satisfied of two things;—that such knowledge must be useful to mankind, not only in enlarging their minds, but in greatly increasing their morality; and also that, however much natural religion may be cultivated, it can never lead to any injurious excesses of enthusiasm, nor render its cultivators bad or dangerous members of society.

* Paley.

It never can induce any man, or body of men, to compass the life of a human being for a difference of opinion. There can be no quarrelling about what can be made obvious to all; and I presume that any one would be laughed at, — I am sure he would deserve it, at least, — who would assert that the pursuit of nature and natural religion can ever lead to cruelty, oppression, lying, burning, hanging, flogging, or flaying. No murders, you may depend upon it, ever have been, or ever will be, committed for its sake; and it never can give rise to attempts at glorifying God by acts of injustice, bloodshed, and murder.

Now, if there be an intellectual pursuit adapted in its very nature, its very essence, to the capacities of all mankind, and all times of life, whose natural tendency is to soften and humanise the dispositions, to keep up a constant reverence for the God of all, by suggesting that Great Being in every thing cognisable by the senses, ought it to be neglected? — a pursuit which leads us to discover the all-powerful Creator in the endless multitude of his works, — is it to be spurned from us and contemned? or should we not rather exert our best efforts to remove the cloud that is settled so deep and wide upon it; to disperse the darkness, and open up, for the amelioration of our species, opportunities of advancing in its delightful paths to a knowledge of nature, and, through her, of the Almighty God whose glorious work she is?

In the observations I have all along made respecting natural history, you will recollect that I have not spoken so much in its favour as I have done from

any bigoted attachment or blind zeal for it in particular, to the exclusion of a due sense of the value of other sciences and pursuits. All knowledge that does not lead to error or immorality is useful and valuable; and without a great diversity of pursuits and inclinations, the business of mankind could not go on. Happy is he, who, in this stage of existence, can acquire the most knowledge, with the greatest degree of innocence; for, along with a good or a guilty conscience, it is the only thing we can take out of the world, and, consequently, is the most valuable thing we can find in it. At the same time, I must repeat, that natural history, being in itself of easy acquirement to a considerable extent, and without previous training; its facts being every where triumphantly illustrative of the wisdom of the Deity; its being adapted to all ages, and admirably so to the enquiring minds of youth; its capability of being studied without interfering with other business or pursuits; and, above all, its being the mirror in which we may, every day and every hour, see in all situations the reflected power, wisdom, and goodness of nature's God; it deserves to be more generally valued and more generally understood than it is.

To conclude: if you have now paid that attention to the letters which I have written, and if they have made such an impression as I could wish, you will not abandon the path in which I have attempted to lead you. Depend upon it, you will always find the highest satisfaction in the pursuit of natural history, especially when in connection with natural religion. You are not in it catching at

objects in the dark, stumbling into a pit here, and following a will-o'-the-wisp there; there are no false lights here to mislead, no traps for the unwary, no impositions for the weak, and no temptations for the wicked; and in pursuing it your life may be one act of rational devotion, and, so far as pleasing occupation can avail, of happiness. Study the Almighty in every thing you can, and get at the truth of every thing as far as you can, but have nothing to do with disputes and controversies respecting things that are above human comprehension; for a man may fight about these for his whole life, and after all leave the world, possessed of very little wisdom, little honour, and less virtue. Search into the works of God with a resolution to find the truth as far as possible; but legitimate nothing as truth which you cannot, on a full and fair investigation, unquestionably and honestly acknowledge to yourself to be such. Consider truth as the gem above all price, as the great reward of your endeavours after knowledge, as your protection from the indulgence of vain and arrogant conceits, and from the equal chance of having your mind crushed to imbecility by childish, absurd, and superstitious fears. Think and study, as every man ought to do, for yourself; but let all your conclusions be satisfactory, if possible: if you see reason for uncertainty in any opinion or statement, neither reject nor embrace such, but keep it *in retentis*, till future observation or reflection shall bring the light of truth to bear sufficiently upon it; so that you can fairly say to yourself, "It is true, and I believe it;" or, "It is false, and I reject it."

With this advice, then, I take leave of you for the present: following the practice I have all along inculcated, that of viewing the works of God in reference to himself, you must pursue the study of natural history with the highest gratification, live as long as you may; and when your final hour arrives, you will have given proof, I doubt not, to your friends, that the remark of the venerable Bewick, "a good naturalist cannot be a bad man," has been fully verified in your past life; and I feel pretty certain that you will, at the approach of that natural termination to your present existence, not be alarmed that death shall put an end to your study of the works of that God, who gave you such opportunities of meditating on him and them during your mortal being here. — Farewell.

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